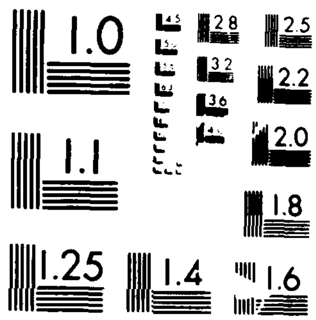
AD-A183 968 INSTALLATION RESTORATION PROGRAM PHASE 2 CONFIRMATION/QUANIFICATION STAGE..(U) AEROVIRONMENT INC MONROVIA CA R BAUER 29 MAY 87 AV-FR-86/517R2-VOL-1 1/4

UNCLASSIFIED F33615-83-D-4000 F/G 24/4 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6

DTIC FILE COPY

(3)

AD-A183 968

VOLUME 1 of 2

INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION

STAGE 1

FINAL REPORT FOR

BEALE AIR FORCE BASE,
MARYSVILLE, CALIFORNIA

AEROVIRONMENT INC.
825 MYRTLE AVENUE
MONROVIA, CALIFORNIA 91016

MAY 1987
FINAL (SEPT 1985 - MAY 1987)

APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED

PREPARED FOR

HEADQUARTERS STRATEGIC AIR COMMAND/COMMAND SURGEON'S OFFICE (SAC/SGPB)/BIOENVIRONMENTAL ENGINEERING DIVISION/OFFUTT AIR FORCE BASE, NEBRASKA 68113

UNITED STATES AIR FORCE/OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY (OEHL)/TECHNICAL SERVICES DIVISION (TS)/BROOKS AIR FORCE BASE, TEXAS 78235

31 044
87 7 ~~30~~ 0~~03~~

AV-FR-86/517R2

INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION

STAGE 1

FINAL REPORT FOR

BEALE AIR FORCE BASE,
MARYSVILLE, CALIFORNIA

STRATEGIC AIR COMMAND
OFFUTT AFB, NEBRASKA

MAY 1987

PREPARED BY

AEROVIRONMENT INC.
825 MYRTLE AVENUE
MONROVIA, CALIFORNIA 91016

CONTRACT NO. F33615-83-D4000, DELIVERY ORDER No. 11
AEROVIRONMENT PROJECT NO. 10416K

CAPT. ROBART BAUER
TECHNICAL SERVICES DIVISION (TS)

UNITED STATES AIR FORCE
OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY (USAFOEHL)
TECHNICAL SERVICES DIVISION (TS)
BROOKS AIR FORCE BASE, TEXAS 78235-5501

NOTICE

This report has been prepared for the United States Air Force by AeroVironment Inc., for the purpose of aiding in the implementation of the Air Force Installation Restoration Program. It is not an endorsement of any product. The views expressed herein are those of the contractor and do not necessarily reflect the official views of the publishing agency, the United States Air Force, nor the Department of Defense.

Copies of this report may be purchased from:

National Technical Information Service
5285 Port Royal Road
Springfield, Virginia 22161

AD-A183968

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION: Unclassified

1b. RESTRICTIVE MARKINGS: N/A

2a. SECURITY CLASSIFICATION AUTHORITY: N/A

2b. DECLASSIFICATION/DOWNGRADING SCHEDULE: N/A

3. DISTRIBUTION/AVAILABILITY OF REPORT: Distribution is unlimited, Approved for public release

4. PERFORMING ORGANIZATION REPORT NUMBER(S): N/A

5. MONITORING ORGANIZATION REPORT NUMBER(S): N/A

6a. NAME OF PERFORMING ORGANIZATION: AeroVionment Inc.

6b. OFFICE SYMBOL *(If applicable)*

7a. NAME OF MONITORING ORGANIZATION: USAF OEHL/TS

6c. ADDRESS *(City, State and ZIP Code)*: 825 Myrtle Avenue, Monrovia, CA 91016

7b. ADDRESS *(City, State and ZIP Code)*: Brooks AFB, Texas 78235-5501

8a. NAME OF FUNDING/SPONSORING ORGANIZATION: Same as 7A

8b. OFFICE SYMBOL *(If applicable)*

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER: F33615-83-D-4000

8c. ADDRESS *(City, State and ZIP Code)*: Same as 7B

10. SOURCE OF FUNDING NOS.

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT NO.

11. TITLE *(Include Security Classification)*: IRP Phase II, Stage 1, Beale AFB

12. PERSONAL AUTHOR(S): AeroVironment Inc.

13a. TYPE OF REPORT: Final

13b. TIME COVERED: FROM 9/85 TO 5/87

14. DATE OF REPORT *(Yr., Mo., Day)*: May 29, 1987

15. PAGE COUNT: 1029

16. SUPPLEMENTARY NOTATION

17. COSATI CODES

FIELD	GROUP	SUB. GR.

18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

AeroVironment Inc. was tasked to conduct a Phase II, Stage 1 IRP survey at Beale AFB near Marysville, California. The objective of this survey was to confirm and quantify the presence and extent of contamination at 18 sites: West Drainage, Photo Waste Injection, FPTA, Battery Shop, SR-71 Shelter, Landfill 2, Biological Production, J-57 Test Cell, Entomology Building 2560, J-58 Test Cell, AGE Maintenance, Entomology Building 440, Landfill 1, Transformer Drainage, Landfill 3, EOD Disposal, Bulk Fuels Storage and Best Slough. Twenty groundwater monitoring wells were drilled and installed (using air rotary with casing hammer drilling and steel well construction). These wells, plus four existing monitoring wells and base production wells were sampled twice and anaylzed for volatile organics and other parameters. In addition, 49 auger borings were drilled, 69 hand samples and bottom sediments were collected from 47 locations and surface waters were collected from eight locations. A geophysical survey was performed on one site.

Goundwater sampling results showed that most of the AV installed wells and all of the base production wells are free of contamination. The wells which do show evidence of contamination are: 1) the well at West Drainage-TCE, 2) both wells at Landfill 1-TCE, 3) 2 of 4 wells at the Photo Waste Treatment Plant -Phenol. Soil contamination resulting from fuel spills was identified at both test cells, AGE Maintenance and SR-71 Shelter. Additional contamination was found as follows: 1) pesticides in soils at Entomology Shop 2560, 2) PCBs in soils at Transformer Drainage, 3) Metals in soil at EOD and 4) oil in surface water and sediment at West Drainage. Additional soil sampling is required at all of the above soil contamination areas. Four additional monitoring wells are recommended. Continued monitoring of most wells will be required to assure that conditions remain stable.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS ☐

21. ABSTRACT SECURITY CLASSIFICATION: Unclassified

22a. NAME OF RESPONSIBLE INDIVIDUAL: Capt. Robart Bauer

22b. TELEPHONE NUMBER *(Include Area Code)*: (512) 536-2158

22c. OFFICE SYMBOL: USAF OEHL/TS

DD FORM 1473, 83 APR — EDITION OF 1 JAN 73 IS OBSOLETE.

PREFACE

This report was prepared by AeroVironment Inc. under task order 11 of contract F33615-83-D-4000. This report is a summary of field activities, data, analysis, conclusions and recommendations prepared as part of the Phase II Stage 1 IRP investigation of Beale AFB.

The project team primarily consisted of Mr. Douglas Taylor, Mr. Timothy O'Gara, Mr. Christopher Lovdahl and Ms. Sheryl Thurston of AeroVironment Inc. Mr. Taylor served as project manager, Mr. O'Gara served as senior geologist, Mr. Lovdahl provided laboratory coordination, and Ms. Thurston assisted with drilling and sampling. Mr. John Keating of Gregg and Associates also served as field geologist on the project.

AeroVironment wishes to acknowledge the assistance of Beale AFB personnel, particularly Capt. Stephen Prawdzik and MSgt. William Priest of the Base Bioenvironmental Engineer's office. Also, the Phase I report prepared by Engineering Science Inc. and the Photo Waste Sludge Ponds Monitoring Report prepared by Radian Corp. were used as information sources throughout this project.

This work was accomplished between September 1985 and July 1986. Capt. Robart Bauer, Technical Services Division, USAF Occupational Environmental Health Laboratory (USAF OEHL) was the technical monitor.

Approved:

Ivar H. Tombach
Program Manager and Vice President

Douglas B. Taylor, P.E.
Project Manager

REGISTERED PROFESSIONAL ENGINEER
DOUGLAS B. TAYLOR
37816
CIVIL
STATE OF CALIFORNIA

SUMMARY

The United States Air Force has developed the Installation Restoration Program (IRP) to assess the environmental effects of past hazardous material handling and disposal activities. As part of that program, the Air Force assigned Task Order No. 11 to AeroVironment Inc., under Contract No. F33615-83-A-D-4000, to conduct a Phase II Stage 1 study of Beale AFB, California. Beale AFB is located about five miles east of Marysville in Yuba County.

A Phase II study, using a staged approach, is intended to confirm the information reported in the Phase I (record search) report and to quantify the concentration and extent of contamination. Phase II Stage 1 was conducted to evaluate potential contamination at 18 sites that had been identified as possible hazardous waste sites. Fifteen sites were identified during Phase I and three were added later, based on information obtained after the Phase I report was completed.

AeroVironment investigated the sites listed below. They are listed in decreasing order of rank according to the ranking assigned during Phase I using the hazard assessment rating methodology (HARM). Their locations are shown in Figure i.

Site 1 -- Discharge Area No. 1.* This is the West Drainage Ditch, which receives all surface water runoff from the runway and flightline shops.

Site 2 -- Photo Wastewater Treatment System. This consists of a treatment plant, injection wells and piping, and two earth-lined sludge ponds.

Site 3 -- The Fire Protection Training Areas (FPTA). During firefighter training, waste jet fuel has been ignited and extinguished in one of two unlined pits.

*During Phase I investigation, drainage areas throughout the base were numbered and designated as "Discharge Areas." This report uses the same designations.

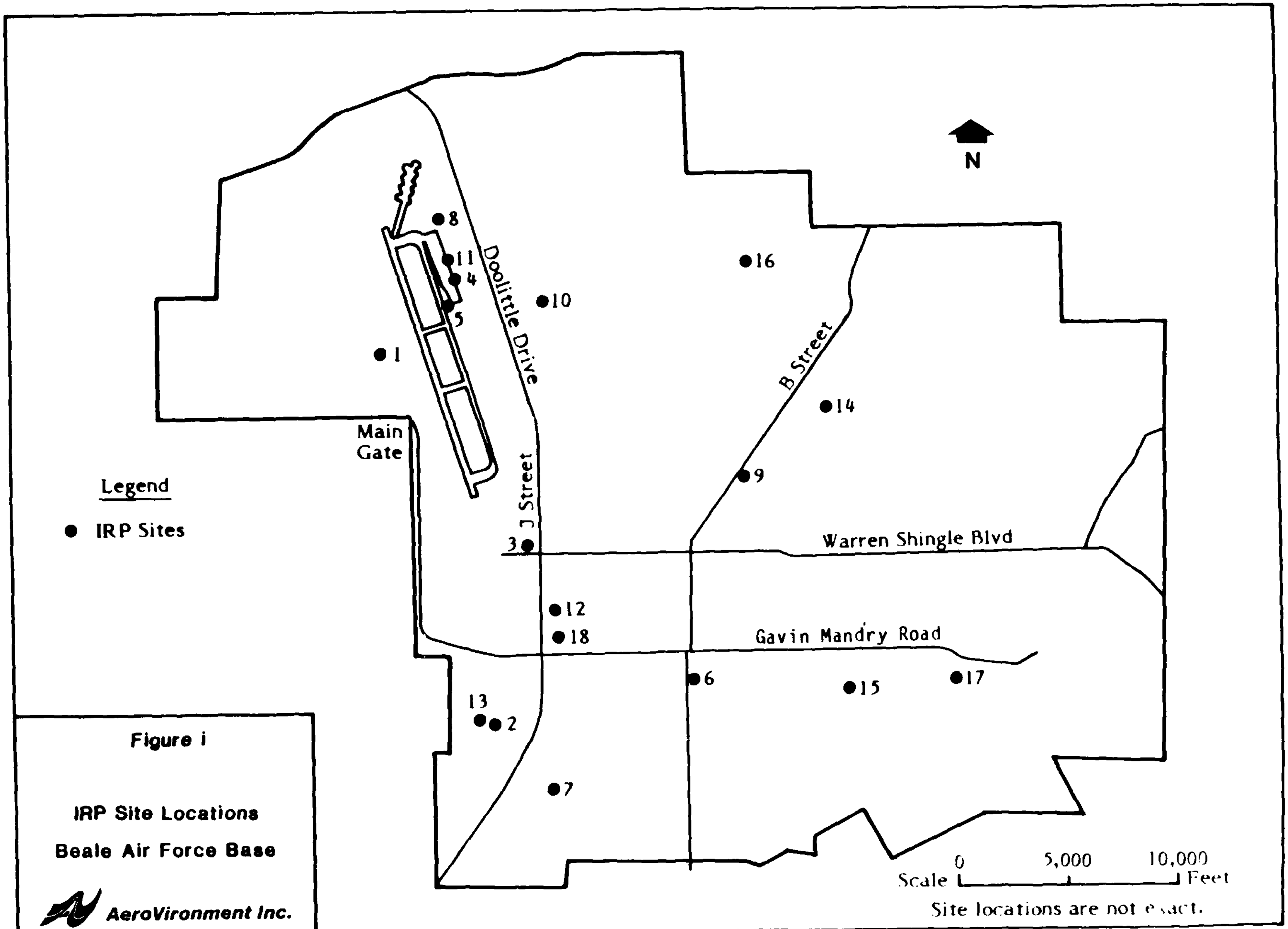


Figure i

IRP Site Locations

Beale Air Force Base

AeroVironment Inc.

Reference: Engineering Science, Phase I IRP Report, April 1984

Site 4 -- Discharge Area No. 2. This is the Battery Shop dry well, a 20-foot boulder-filled hole used for disposal of neutralized battery acid.

Site 5 -- Dishcarge Area No. 3. This is the drainage swale west of the SR-71 aircraft shelter. This area receives runoff from the taxiway and SR-71 apron.

Site 6 -- Landfill No. 2. This was the base's sanitary landfill from 1967 to 1978.

Site 7 -- Discharge Area No. 4. During World War II, the base belonged to the Army, which used this area as a biological test site for research on wheat stem rust. Unused stock is reported to have been treated with chemicals, incinerated, and the ashes plowed into the ground in 1969.

Site 8 -- Discharge Area No. 6. This area receives the runoff from the test stand used to test KC-135 and T-38 jet aircraft engines at the J-57 Test Cell.

Site 9 -- Discharge Area No. 9. Washwater from cleaning pesticide application equipment runs off from the Entomology Shop, Building 2560, to this area.

Site 10 -- Discharge Area No. 5. This area receives runoff from the J-58 Test Cell, where SR-71 aircraft engines are tested.

Site 11 -- Discharge Area No. 7. This is the drainage ditch from the Aircraft Ground Equipment (AGE) Maintenance Facility, where ground support equipment is serviced and tested.

Site 12 -- Discharge Area No. 10. This was a civil engineering Entomology Branch (Building 440) in which pesticides and herbicides were stored and prepared from 1965 to 1980.

Site 13 -- Landfill No. 1. This was the base sanitary landfill during the 1940's.

Site 14 -- Discharge Area No. 8. In this small bermed area transformers were drained of oil before repair.

Site 15 -- Landfill No. 3. This is the landfill the base now uses. It opened in 1981 and is permitted by the state as a Class III (nonhazardous) landfill.

Site 16 -- Explosives Ordnance Disposal (EOD) Range Area. This area is used for demolition and burning of explosives, pyrotechnics and munitions. A trench at the site receives scrap metal and residual material generated from the burning and demolition processes.

Site 17 -- Best Slough. Empty deteriorating 55-gallon drums were recently discovered in several trenches in January 1985.

Site 18 -- Bulk Fuel Storage Facility. Jet fuel, gasoline, diesel fuel and fuel oils are stored in above-ground tanks. Fuel loading and unloading operations are also conducted in this area.

Testing Conducted

From October 22 to November 6, 1985, 38 hollow-stem auger borings (generally 15 feet deep) were drilled and sampled at eight sites. Every three to five feet, drilling was halted, the drilling plug removed from the auger's hollow stem, and the split-spoon sampler inserted. The sampler held three six-inch-long, two-inch-outer-diameter mild steel cylinders. The sampler was driven into the ground by a hammer and the three cylinders filled with soil. These were then removed, capped and refrigerated and drilling continued to the next sampling depth.

Similarly, surface soil and sediment samples were collected at ten sites in November 1985 by driving a split-spoon sampler containing a single six-inch

cylinder, two inches in inner diameter into the earth. Surface water samples were taken at three sites in November 1985 and April 1986 by placing bottles in the water and allowing them to fill.

Twenty groundwater-monitoring wells were installed during the project. Air rotary drilling with casing hammer was the method used to complete the drilling. Wells were constructed with 20-foot stainless steel screens and mild steel risers. All wells were installed with artificial gravel packs and bentonite clay seals. Development was completed with a combination of pumping and jet air-lifting.

These 20 monitoring wells plus four existing monitoring wells at Site No. 2 were sampled by collecting water from a valve at the wellhead. All groundwater samples were collected twice (except for one monitoring well and one production well sampled only once each).

All samples were sent to the Acurex laboratory in Mountain View, California, for chemical analyses. All field work was completed in April and Acurex Corporation completed all laboratory work in May 1986.

Table i summarizes work completed for the project.

Results

Samples collected during this study show that only three of the eighteen sites have elevated concentrations of contaminants in the groundwater. In wells at the West Drainage and Landfill No. 1, trichlorethylene (TCE) was detected at levels exceeding the California Department of Health Services action levels. One monitoring well at the photo wastewater treatment plant area contains levels of chromium above the Primary Drinking Water Standard. Phenol and other phenolic compounds were also detected in several monitoring wells, but the analytical sensitivity of the specified method was not low enough to allow precise quantification of the concentrations.

TABLE i. Summary of completed activities.

Site No.	Site Name	No. of Monitoring Wells Installed*	No. of Soil Borings (& Samples)	Soil Samples Collected By Hand	Surface Water Samples	Sediment Samples
1	West Drainage	1	-	-	3	5
2	Wastewater Injection Wells	1	4 (9)	-	-	
3	FPTA	5	8 (26)	10 (5 locations)	2	2
4	Battery Shop	1	-	-	-	
5	SR-71	1	6 (18)	-	-	
6	Landfill No. 2	4	-	-	-	
7	Biological Production	-	-	4 (composited from 16 locations)	-	
8	J-57 Test Cell	1	-	6 (4 locations)	-	
9	Entomology Building 2560	-	3 (6)	-	-	
10	J-58 Test Cell	1	-	7 (4 locations)	-	
11	AGE Maintenance	1	4 (8)	7 (4 locations)	-	
12	Entomology Building 440	-	3 (6)	-	-	
13	Landfill No. 1	2	-	-	4	8
14	Transformer Drainage	-	-	12	-	
15	Landfill No. 3	2	-	-	-	
16	EOD	-	-	2 (2 locations)	-	
17	Best Slough	-	6 (12)	6	1	
18	Bulk Fuels Storage	-	4 (16)	-	-	

*Sampled twice each. Also sampled twice were seven base water production wells (one sampled only once) and four monitoring wells located at the Photo Waste Sludge Ponds (one sampled only once). Production wells are part of Site 1 in the Statement of Work. Sludge Pond wells are part of Site 2.

Soil sample results showed evidence of hydrocarbons at only five of the 18 sites studied. In each case, the hydrocarbons in the soil have resulted from the use of POL on the flightline and maintenance areas of the base. There does not appear to be any extensive migration of the hydrocarbons either laterally or vertically. Detectable hydrocarbons did not extend below the first few feet of soil and no groundwater contamination was identified at these sites. Hydrocarbons were identified in analysis of soil samples from six locations: the burn pit at FPTA No. 2, the underground storage tank at FPTA No. 2, the drainage channel around the J-57 Test Cell, the drainage channel around the J-58 Test Cell, the soil behind the AGE Maintenance parking apron, and the soil between the SR-71 apron and the flightline taxiway.

In addition, localized deposits of nonfuel compounds were detected in soil samples at four locations. PCBs and oil and grease were found at levels of 5.3 and 38,000 μg/g (ppm), respectively, in the surface soil at one portion of the Transformer Drainage Area. Chlordane was found at a concentration 0.9 μg/g in the surface soil below the mixing basin at the current Entomology Shop (Building 2560). The concentrations of chlordane found at these two sites is below the state of California Total Threshold Limit Concentrations. The bottom of the disposal trench at the EOD contains levels of lead (14,000 μg/g) high enough to classify the soil as hazardous waste according to California Title 22 standards. Finally, potential pentachlorophenol soil contamination was identified at Injection Well No. 2, but other nearby samples showed no evidence of pentachlorophenol.

Surface water samples collected along the ditch bank at the West Drainage site contained oil and grease (probably jet fuel). In the second sampling round, the water at the head of the ditch contained almost 2% (20,000 μg/g) hydrocarbon. Downstream sediment samples were also high in fuel components -- up to 3% (30,000 μg/g) by weight. There was very little flow from this drainage system either time the water was sampled so downstream impacts could not be assessed. Samples from Hutchinson Creek, near Landfill No. 1, contained the pesticide aldrin; however, the aldrin was also found in upstream (background) samples, suggesting that the source is not Landfill No. 1.

Conclusions and Recommendations

Seven of the sites at Beale AFB show no evidence of contamination and do not appear to pose any environmental risk based on the following criteria: 1) no contaminants were found at concentrations above state action levels, 2) no contaminants were found in deep soils or groundwater, and 3) sites are not located near residential areas. Another five sites showed limited contamination, but do not warrant further investigation. Table ii summarizes specific recommendations for each site.

Only the EOD site is currently considered appropriate for Phase IV remedial action (in association with some continued Phase II study). However, non-IRP actions are appropriate for some sites to eliminate or minimize future releases of fuels and other chemical compounds.

Groundwater contamination (TCE) has been identified at the West Drainage and at Landfill No. 1. Samples from the two wells at Landfill No. 1 show substantial fluctuation and additional sampling will be necessary to establish more precise results at that site. TCE contamination at the West Drainage is well defined. Although the current groundwater flow pattern is not directly toward base production wells, a change in pumping patterns could place the base production wells down gradient from the TCE contamination at West Drainage. In addition, one of the monitoring wells at the Photo Waste Sludge Pond contains levels of chromium above the Federal Drinking Water Standard. Phenol and other phenolic compounds were identified in Sludge Pond wells, but more precise analytical methods are needed to determine actual concentrations. Continued sampling will be required at all wells at the West Drainage, Landfill No. 1 and Photo Waste Sludge Pond (plus the monitoring well at the injection well).

Surface water at West Drainage is also contaminated with fuel and other hydrocarbons. Controlling this contamination will require better management of fuels, lubricants and other chemicals throughout the flightline area. Runoff from other IRP sites enters the West Drainage system so that any contaminants from these other sites may also contribute to contamination at West Drainage. In

TABLE ii. Recommendations.

Site		Recommendation
1	West Drainage	- Install three groundwater monitoring wells, two between Site 1 and the base production wells and a third at the base boundary, downgradient from the site. - Sample the 4 wells (1 existing and 3 proposed) and test for VOCs (EPA 601/602) and oil & grease (EPA 413.2) - Sample surface water and stream bottom sediments at 8 downstream locations. . Analyze surface water for VOCs (EPA 601/602), lead (EPA 239.2), and oil & grease (EPA 413.2). . Analyze bottom sediment for VOCs (EPA 8010/8020 + 5030), lead (EPA 239.2 + 3050), and oil & grease (EPA 3550/413.2) - Identify sources of organic material which flow into west ditch and implement a plan to eliminate the flow of contaminants to this site.
2	Injection Well No. 2	- Drill 3 soil borings to 30 feet near the inactive injection wells. Analyze for Phenols (EPA 8040 +3550), 8 Metals (Series 200 + EPA 3050) and oil & grease (EPA 413.2 + 3550). - Continue monitoring the 5 wells on site (1 at injection wells and 4 at sludge disposal area) and analyze for Phenols (EPA 604), Benzene (EPA 602) and 8 Metals (Series 200).
3	Fire Protection Training Area	- Continue monitoring the 5 existing wells. Sample groundwater for VOCs (Method 601/602). - Drill up to 8 additional soil borings near the underground tanks and burn pit. Analyze soil samples for oil and grease (EPA 3550 extraction, EPA 413.2 analysis) and VOCs (EPA 8010/8020 + 5030). - Remove the underground storage tanks as a Phase IV activity.

TABLE ii. (con't)

4	Battery Shop Dry Well	-	No further action is recommended.
5	SR-71 Shelters	-	Drill up to 8 additional 20-foot soil borings between the taxiway and SR-71 apron, analyze for volatile aromatics (EPA 8020 +5030) and oil & grease (EPA 413.2 +3550).
		-	Continue monitoring groundwater in the existing well, analyze for volatile aromatics (EPA 602) and oil & grease (EPA 413.2).
		-	Collect up to 10 hand auger samples from 5 locations along the edge of the SR-71 shelter apron. Analyze for same parameters as soil boring samples.
6	Landfill No. 2	-	No further action is recommended.
7	Biological Production Site	-	No further action is recommended.
8	J-57 Test Cell	-	No further IRP action is recommended. However, a fuel spill management plan should be implemented to minimize further fuel releases.
9	Entomology Shop, Bldg. 2560	-	No further IRP action is recommended. However, the existing gravel basin should be replaced with an impermeable basin and a liquid collection system.
10	J-58 Test Cell	-	No further IRP action is recommended. However, a fuel spill management plan should be implemented to minimize further fuel releases.
11	AGE Maintenance	-	No further IRP action is recommended. However, a fuel spill management plan should be implemented to minimize further fuel releases.
12	Entomology Shop, Bldg. 440	-	No further action is recommended.

TABLE ii. (Con't)

13	Landfill No. 1	-	Continue monitoring existing wells semiannually, sample for TCE (Method 601) and Phenol (Method 604)
		-	If warranted after continued sampling of existing wells, install 2 additional wells upgradient and downgradient of Landfill 1 near property line.
14	Transformer Drainage	-	No further IRP action is recommended. However, the berm should be removed and the soil used to cover the surface of the site.
15	Landfill No. 3	-	No additional IRP work is needed. However, the base should continue necessary groundwater monitoring for landfill permit.
16	EOD	-	Install 1 groundwater monitoring well. Sample groundwater and analyze for metals (Series 200).
		-	Install 3 temporary piezometers to determine groundwater gradient before selecting the well location.
		-	Phase IV remedial action Determine depth and excavate soil from beneath waste metal trench.
17	Best Slough	-	No further action is recommended.
18	Bulk Fuel Storage Facility	-	No further IRP action is recommended. However, the base should consider the installation of two monitoring wells to monitor for leaks which may occur from the fuel storage area.

addition to more sampling and two additional monitoring wells at this site, a comprehensive spill and runoff management program is needed.

Soil samples from several sites contained detectable POL/chemicals; however, groundwater sampling at these sites showed no contamination. Additional soil sampling is needed to define the extent of contamination at the SR-71 Shelter, FPTA, Injection Well No. 2 and EOD. The EOD site will also require a groundwater monitoring well to check for heavy metals in the groundwater. Although hydrocarbons or other organic compounds were detected at several other sites, no additional IRP work is needed because of the limited extent and low concentrations (below any applicable standards).

Additional soil/sediment sampling is recommended for the West Drainage site, Photo Wastewater Injection Well area, FPTAs and SR-71 Shelter area. Three additional monitoring wells are recommended for the West Drainage (2) and EOD area (1). Other wells may be needed based upon further sampling of existing monitoring wells.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

LIST OF TABLES (Cont.)

I. INTRODUCTION

A. Installation Restoration Program

In 1976, the Department of Defense (DoD) devised a Comprehensive Installation Restoration Program (IRP), the purpose of which is to assess and control migration of environmental contamination that may have resulted from past operations and disposal practices on DoD facilities and to assess the probable migration of hazardous contaminants. In response to the Resource Conservation and Recovery Act of 1976 (RCRA) and in anticipation of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA or "Superfund"), the DoD issued a Defense Environmental Quality Program Policy Memorandum dated June 1980 (DEQ 80-6) requiring the identification of past hazardous waste disposal sites on DoD agency installations. The U.S. Air Force (USAF) implemented DEQPPM 81-5 (December 11, 1981), which reissued and amplified all previous directives and memoranda on the IRP. The Air Force implemented DEQPPM 81-5 on January 21, 1982. The Installation Restoration Program has been developed as a four-phase program, as follows:

- o Phase I - Problem Identification/Records Search
- o Phase II - Problem Confirmation and Quantification
- o Phase III - Technology Base Development
- o Phase IV - Corrective Action

B. Installation Restoration Program History at Beale Air Force Base

AeroVironment Inc. (AV) was retained by the U.S. Air Force Occupational and Environmental Health Laboratory (USAF OEHL) under Contract F33615-80-D-4000b, to provide general engineering, hydrogeological and analytical services. The following are the objectives of the Phase II, Stage 1 investigation at Beale Air Force Base, California:

(1) To determine the presence or absence of contamination at the locations specified for investigation.

(2) If contamination exists, to determine the potential for migration of those contaminants in the various environmental media.

(3) To identify additional investigations necessary to determine the magnitude, extent, direction and rate of migration of discovered contaminants.

(4) To identify potential environmental consequences of and health risks from migrating pollutants.

In the IRP Phase I record search for Beale (conducted by Engineering Science), 16 sites were identified as possible or known hazardous waste disposal sites. They were ranked using the hazard assessment rating methodology (HARM). The Phase I report recommended that the six highest-ranked sites be investigated further in Phase II, Stage 1. Discussions among USAF OEHL, base officials and California regulatory personnel (Department of Health Services and Water Quality Control Board) and EPA Region IX resulted in all 16 identified sites being included into the Phase II, Stage 1 study. At the time of the Phase II Stage 1 Presurvey, (conducted by Roy F. Weston Inc.), the Explosives Ordnance Disposal area (EOD) was added to the site list. Later, the Photo Wastewater Treatment Plant and injection wells, which had been separate sites, were combined into one. Finally, just prior to beginning actual Phase II field work, two additional sites were included: the Bulk Fuels Storage Area and the Best Slough drum disposal site. The final 18 Phase II, Stage 1 sites are, in order of decreasing HARM ranking:

Site 1	Discharge Area No. 1, West Drainage Ditch
Site 2	Photo Wastewater Treatment Plant and Injection Well (formerly sites No. 2 and No. 3)
Site 3	Fire Protection Training Areas (Nos. 1 & 2)
Site 4	Discharge Area No. 2, Battery Shop Dry Well
Site 5	Discharge Area No. 3, SR-71 Shelter

Site 6	Landfill No. 2
Site 7	Discharge Area No. 4, Army Biological Production Site
Site 8	Discharge Area No. 6, J-57 Test Cell
Site 9	Discharge Area No. 9, Entomology Building 2560
Site 10	Discharge Area No. 5, J-58 Test Cell
Site 11	Discharge Area No. 7, Aircraft Ground Equipment Maintenance Drainage Ditch
Site 12	Discharge Area No. 10, Entomology Building 440
Site 13	Landfill No. 1
Site 14	Discharge Area No. 8, Transformer Drainage
Site 15	Landfill No. 3
Site 16	Explosive Ordnance Disposal (EOD) Area
Site 17	Best Slough
Site 18	Bulk Fuel Storage Facility

Table I-1 summarizes the investigative effort for each of these sites. AV installed 20 groundwater monitoring wells at 11 sites throughout the base. Samples were collected from these 20 wells plus monitoring wells at the Photo Wastewater Treatment Plant and base water production wells. At Landfill No. 1, AV conducted geophysical surveys to define the site boundaries and to help select well locations. AV also collected soil samples using hollow stem augers from 8 sites and hand-collected surface soil samples at 10 more. Surface water and sediment samples were collected at 3 sites.

C. Duration of the Program

The IRP program began at Beale Air Force Base (AFB) with a Phase I records search conducted in January-April 1984 by Engineering-Science Inc. The Phase I report identified 16 sites as potentially contaminated, but recommended further work on only the top six sites (based on HARM scores). In February 1984, USAF OEHL conducted a presurvey for the Phase II, Stage 1 effort. At that time, USAF had decided to look at all 16 sites identified in Phase I, and the EOD area. Between November 1984 and May 1985, two additional sites were added to the Phase II, Stage 1 study, and the two-site designation for the Photo Wastewater

TABLE I-1. Summary of planned activities.

Site No.	Site Name	Monitoring Wells Installed*	No. of Soil Borings (& Samples)	Soil Samples Collected By Hand	Surface Water Samples	Sediment Samples
1	West Drainage	1	-	-	4	8
2	Wastewater Injection Wells	1	4	-	-	
3	FPTA	5	8 (24)	10 (5 locations)	2	2
4	Battery Shop	1	1 (8)	-	-	
5	SR-71	1	6 (18)	-	-	
6	Landfill No. 2	4	-	-	-	
7	Biological Production	-	-	4 (composited from 16 locations)	-	
8	J-57 Test Cell	1	-	6 (3 locations)	-	
9	Entomology Building 2560	-	3 (6)	-	-	
10	J-58 Test Cell	1	-	8 (4 locations)	-	
11	AGE Maintenance	1	4 (8)	8 (4 locations)	-	
12	Entomology Building 440	-	3 (6)	-	-	
13	Landfill No. 1	2	-	-	4	8
14	Transformer Drainage	-	-	12	-	
15	Landfill No. 3	2	-	-	-	
16	EOD	-	-	2	-	
17	Best Slough	-	6 (12)	6	1	
18	Bulk Fuels Storage	-	4 (16)	-	-	

*All wells were sampled two times. Also, 7 base water production wells at the west end of the base and 4 monitoring wells at the Photo Wastewater Treatment Plant (called Radian Wells) were sampled. Production wells were studied as part of Site No. 1 and Radian Wells were studied as part of Site No. 2.

Treatment and Injection System were combined into one. This resulted in 18 sites to be investigated. On September 25, 1985 AV received authorization to conduct the Phase II, Stage 1 survey at Beale AFB.

Hollow-stem auger drilling began on October 22, 1985, and continued until November 16, 1985. Well drilling and development began on October 28, 1985, and was completed on January 8, 1986 (with the exception of Well 01-01, which was drilled and completed in March 1986). Shallow soil samples and surface water samples were collected on November 19-23, 1985. AV collected groundwater samples twice during the project: January 6-10, 1986, and April 14-18, 1986. The second round of water sampling included surface waters. All field work was completed by April 18, 1986. Laboratory analyses were completed by May 15, 1986.

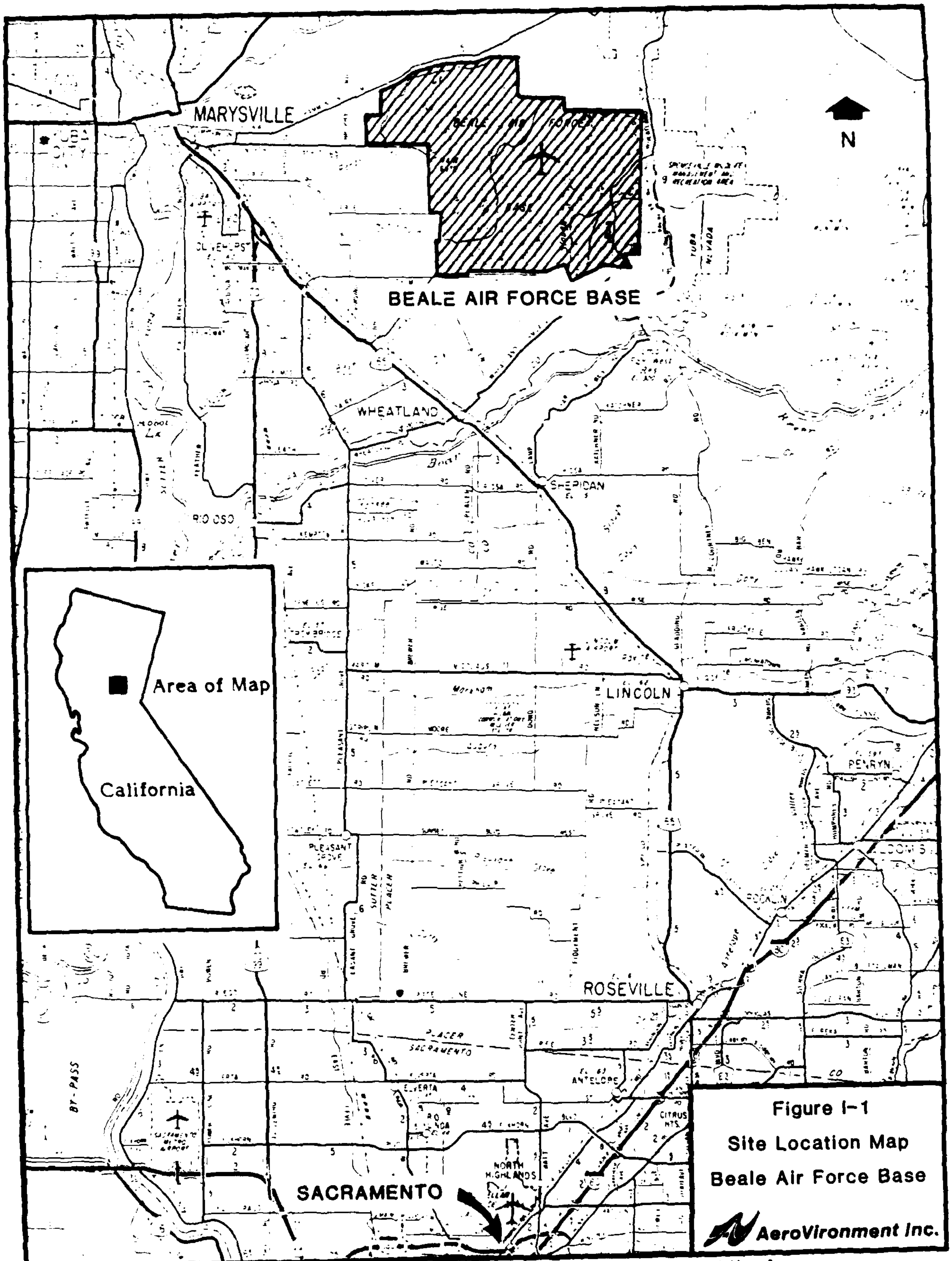
D. Base History*

Beale Air Force Base (see Figures 1-1 and 1-2) opened in October 1942 as Camp Beale. The 13th Armored Division was the first unit to be actively trained there. However, during the course of World War II, the 81st and 96th Infantry Divisions were also trained there. In addition, the camp was used as a personnel replacement depot and prisoner-of-war encampment. It was the site of a 1,000-bed hospital and, at the end of the war, was used as the west coast separation center.

In 1947, Camp Beale was declared surplus by the War Department and the War Assets Administration assumed custody. In early 1948, it was transferred to the United States Air Force. Until 1951, the base was used for bombardier-navigator training.

In 1951, the Department of the Air Force redesignated the Beale Bombing and Gunnery Range as "Beale Air Force Base." During its early years in

*The information presented in this section was taken primarily from the Engineering Science Phase I IRP Report and on-site observations and interviews during Stage 1.



Reference: Sacramento Valley Region Map, California State Automobile Assoc.
Approximate Scale 1" = 4 Miles

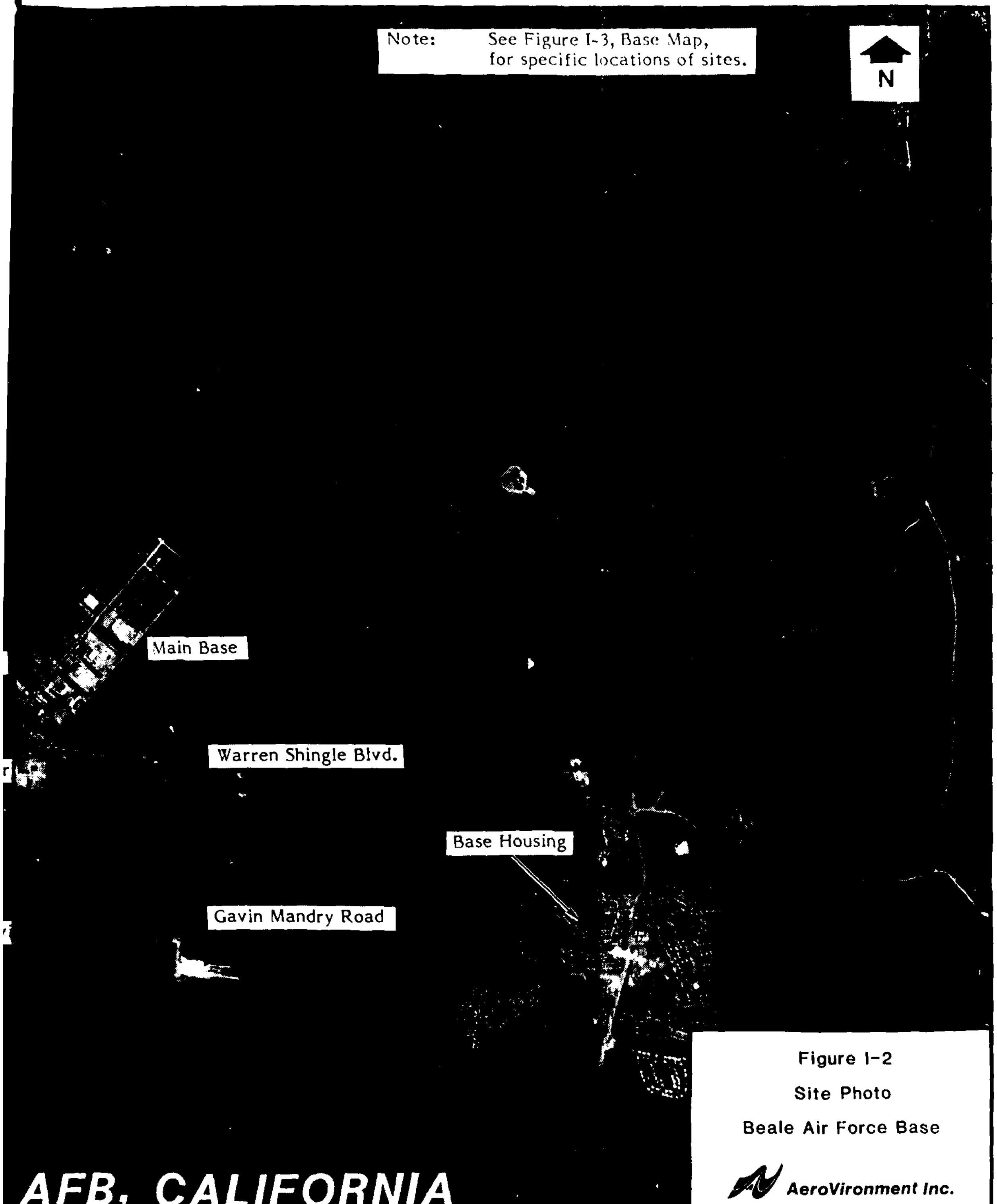


Figure I-2
Site Photo
Beale Air Force Base

AeroVironment Inc.

the Air Force, it underwent a number of jurisdictional changes, being, at times, part of the Air Training Command, the Aviation Engineer Force and, finally, the Strategic Air Command. By 1958, Beale's first runway was operational.

In July 1959, Beale received its first KC-135 jet Stratotanker, which was assigned to the 903rd Air Refueling Squadron of the 456th Bombardment Wing. In September 1959, Beale became the support base for three Titan I missile sites. In 1960, B-52s were assigned to the base. In 1965, the Titan I missile program was inactivated and the 4200th Strategic Reconnaissance Wing, which would man and maintain the SR-71, activated.

In 1976, as a result of a major reorganization at Beale, all B-52 aircraft were reassigned. At the same time, the 9th Strategic Reconnaissance Wing gained U-2 aircraft and the 99th Strategic Reconnaissance Squadron.

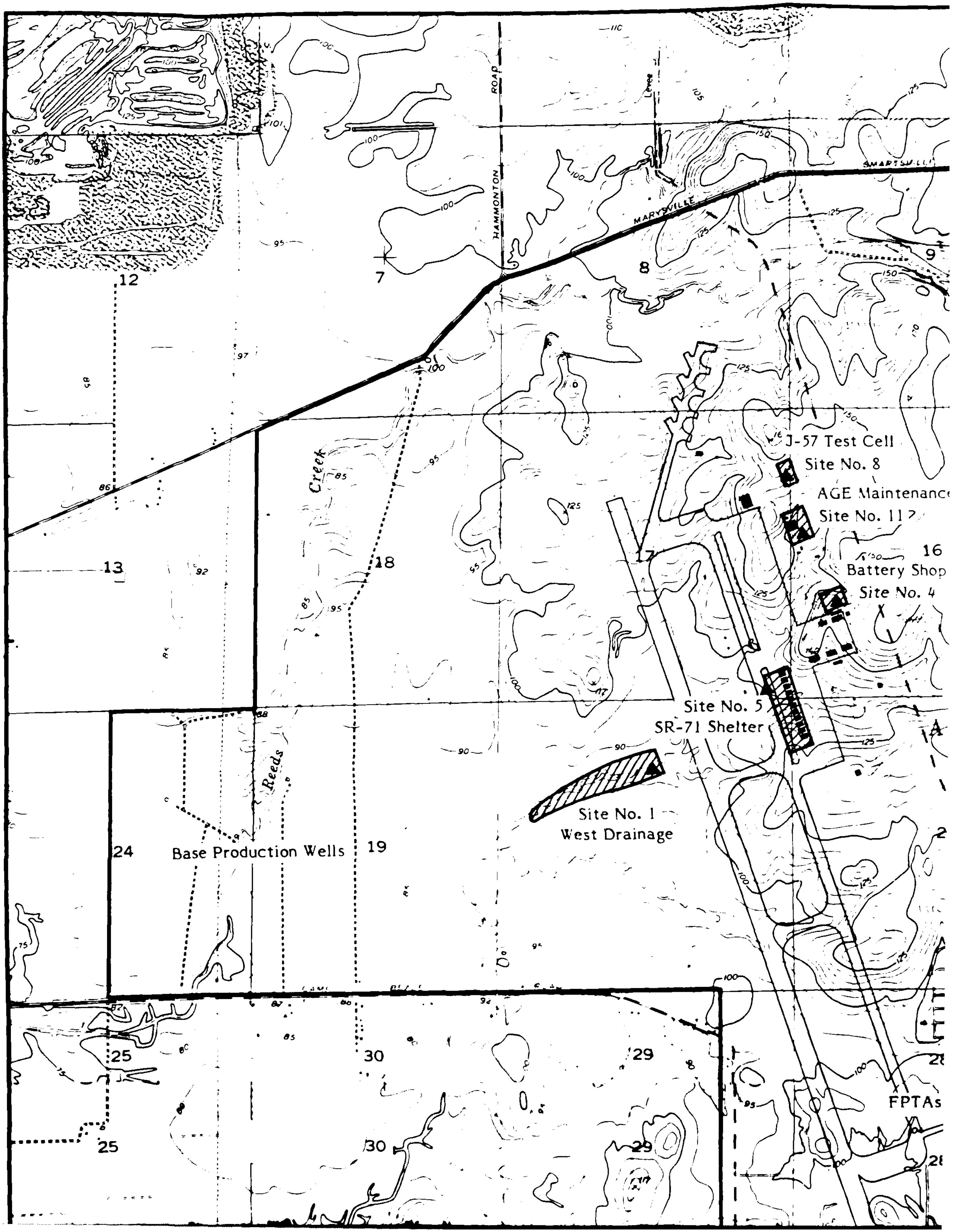
In 1979, a phased array radar system was installed. The 10-story phased-array radar is a detection and early warning system against sea-launched ballistic missile (SLBM) attacks on the continental United States.

The following subsections give the history and location of the sites chosen for investigation during this phase. Figure I-3 shows the location of these sites. These locations will be shown more precisely in Chapter IV.

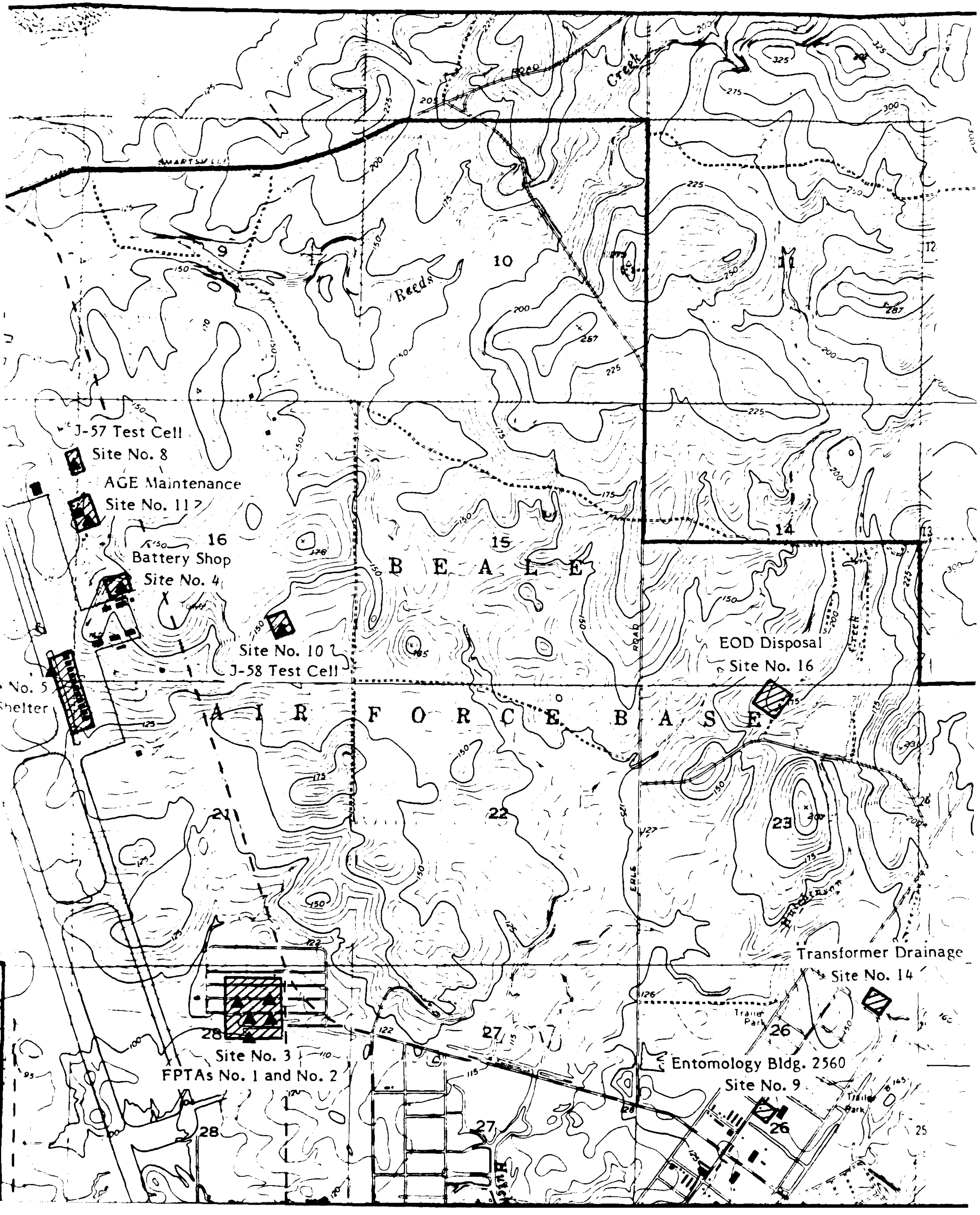
1. Discharge Area No. 1 (West Drainage Ditch)

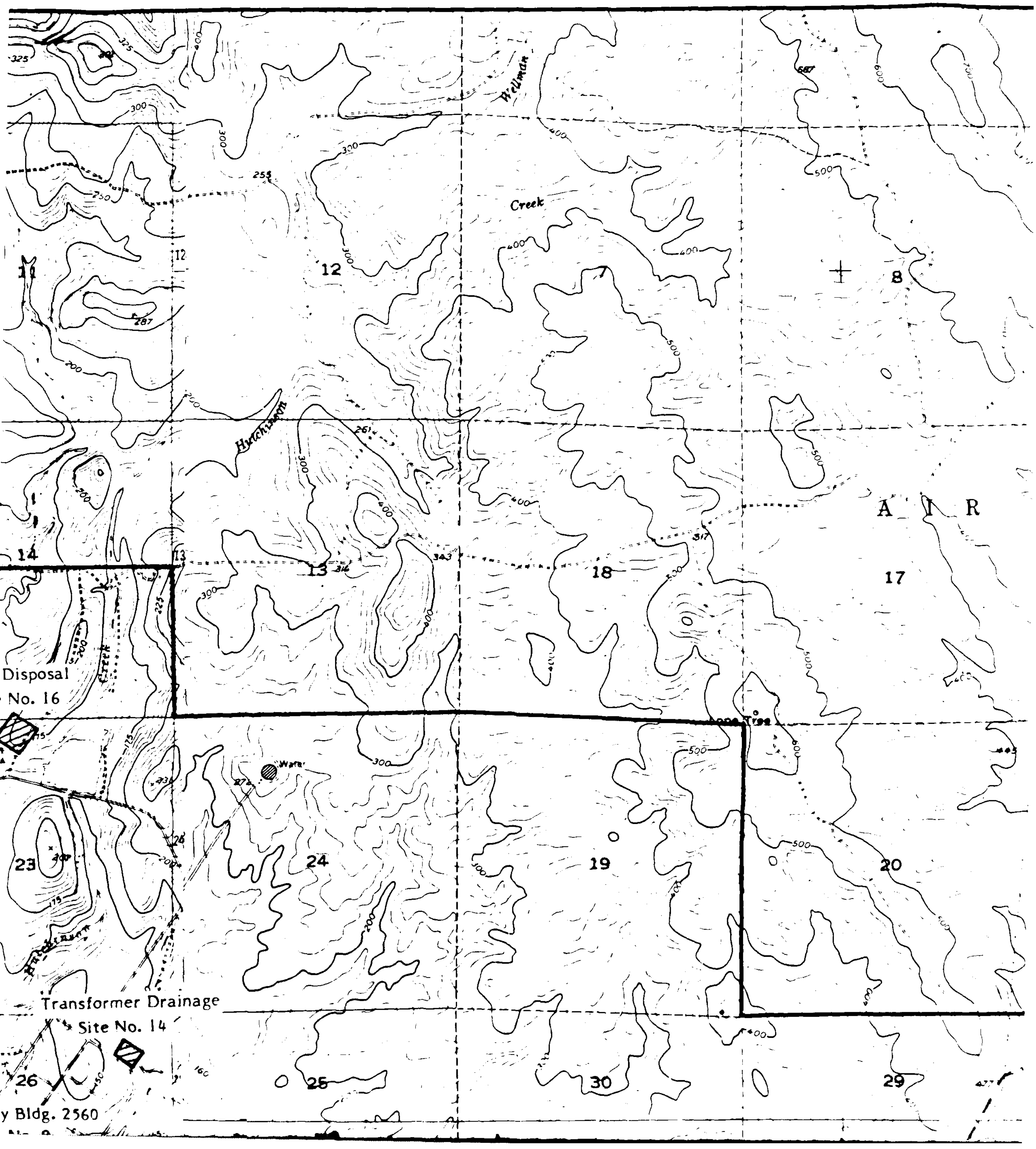
Since 1965, the West Drainage Ditch has received runoff from the flightline as well as the runway area. It discharges through a headwall located about 800 feet west of the main runway. Surface water quality data have documented oil and grease, trans-1,2 dichloroethene and trace amounts of TCE (Engineering Science, 1984).

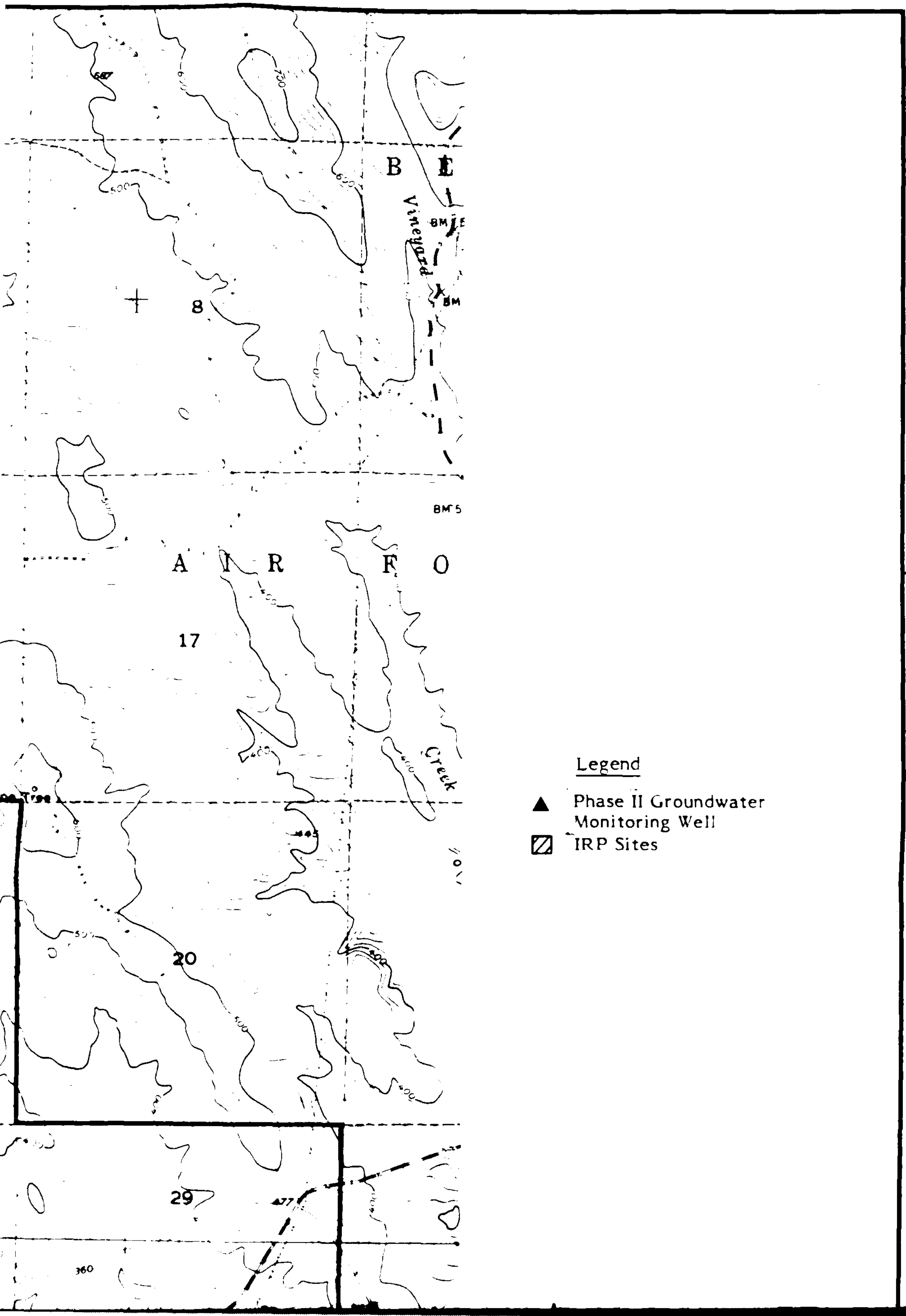
(THIS PAGE LEFT BLANK INTENTIONALLY)



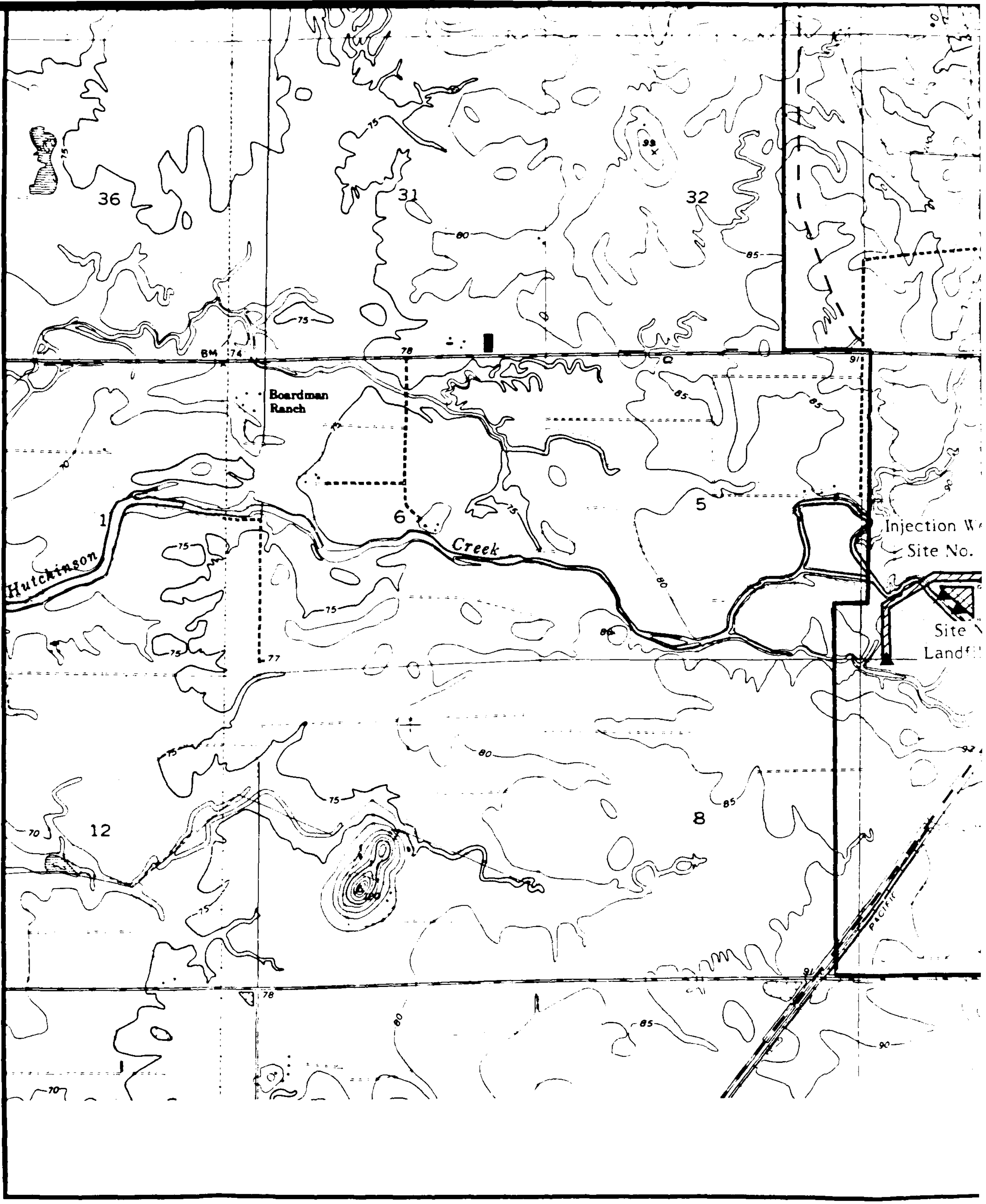
HAMMONTON ROAD
MARYSVILLE
SMARTSVILLE
J-57 Test Cell
Site No. 8
AGE Maintenance
Site No. 11
Battery Shop
Site No. 4
Site No. 5
SR-71 Shelter
Site No. 1
West Drainage
Base Production Wells
Reeds Creek
FPTAs
12
13
24
25
7
18
19
30
8
29
9
16

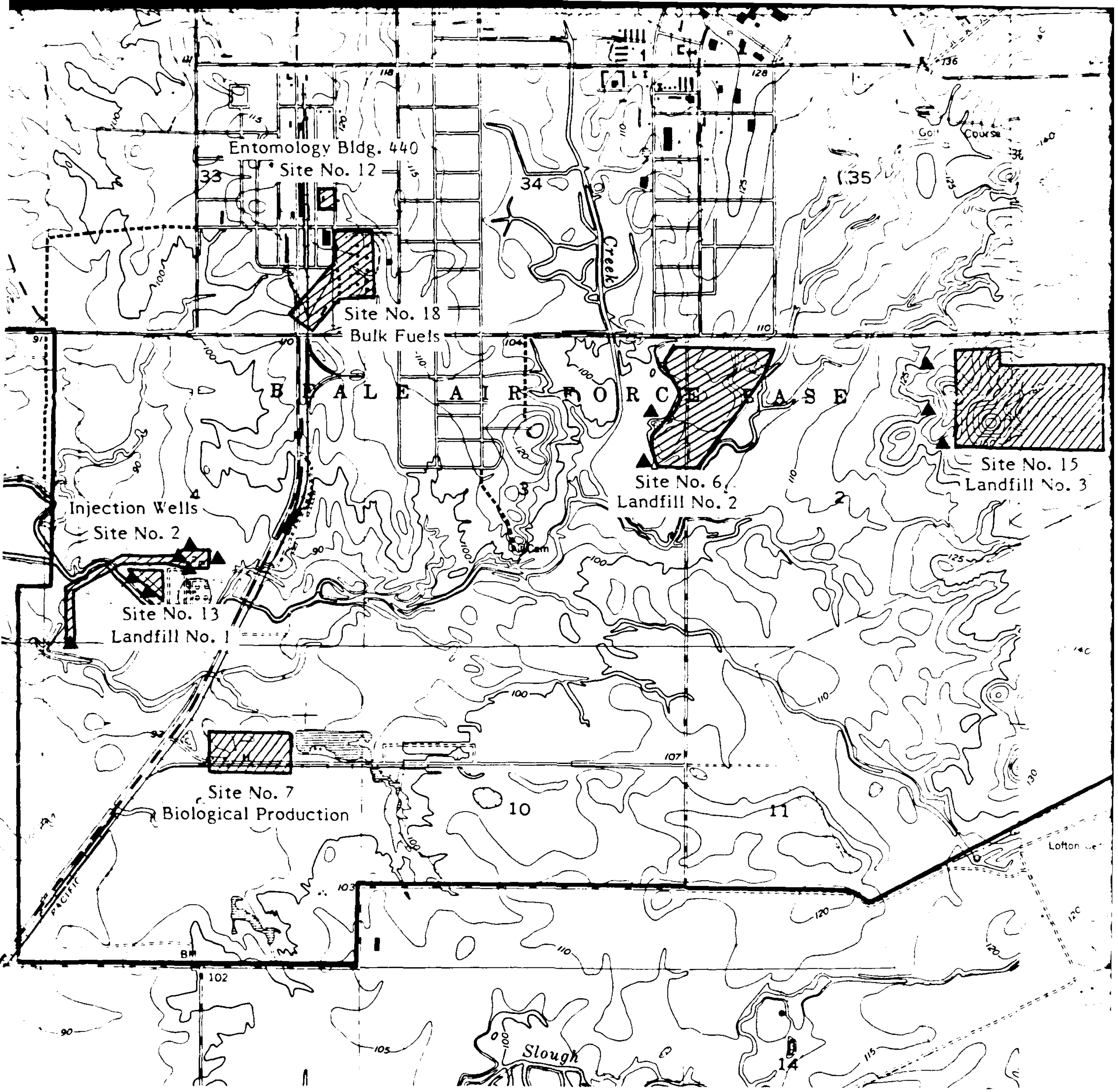

J-57 Test Cell
Site No. 8
AGE Maintenance
Site No. 11
Battery Shop
Site No. 4
Site No. 10
J-58 Test Cell
No. 5
Shelter
EOD Disposal
Site No. 16
Transformer Drainage
Site No. 14
Site No. 3
FPTAs No. 1 and No. 2
Entomology Bldg. 2560
Site No. 9
BEALE
AIR FORCE BASE
Reeds
Creek
Trailer Park


Wellman
Creek
Hutchinson
Creek
A I R
Lone Tree
Disposal
No. 16
Transformer Drainage
Site No. 14
y Bldg. 2560
11
12
7
8
14
13
18
17
23
24
19
20
26
25
30
29



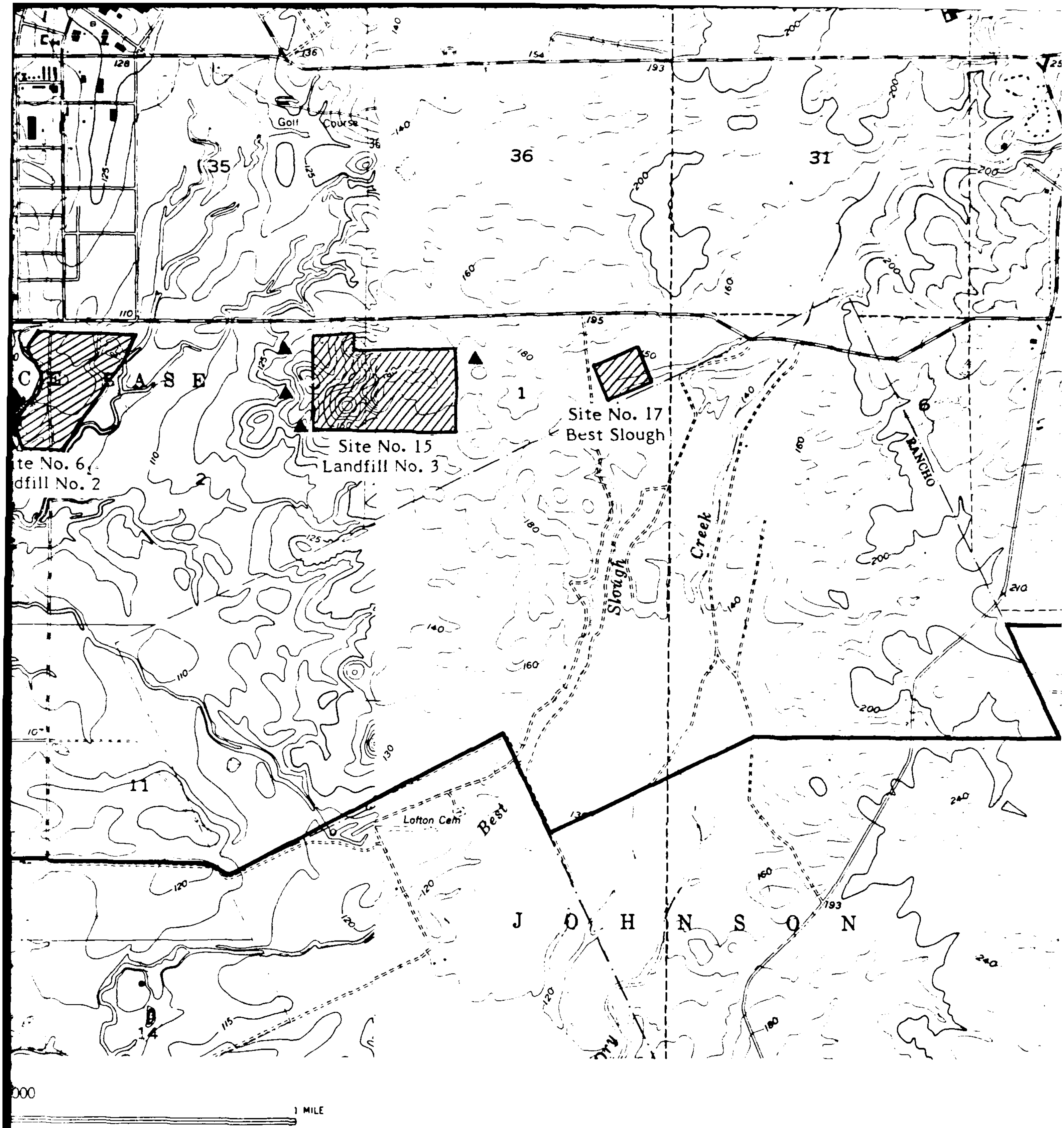
B E
Vineyard
A I R F O
8
17
20
29
Creek
Legend
Phase II Groundwater Monitoring Well
IRP Sites


36
31
32
Boardman
Ranch
Hutchinson
Creek
6
5
1
Injection W
Site No.
Site
Landf
12
8
PACIFIC



SCALE 1:24000

0 1 MILE



Golf Course
35
36
31
CE EASE
Site No. 15
Landfill No. 3
Site No. 17
Best Slough
te No. 6
dfill No. 2
1
2
6
11
14
RANCHO
Slough
Creek
Best
Lofton Cem
JOHNSON
Dry
000
1 MILE

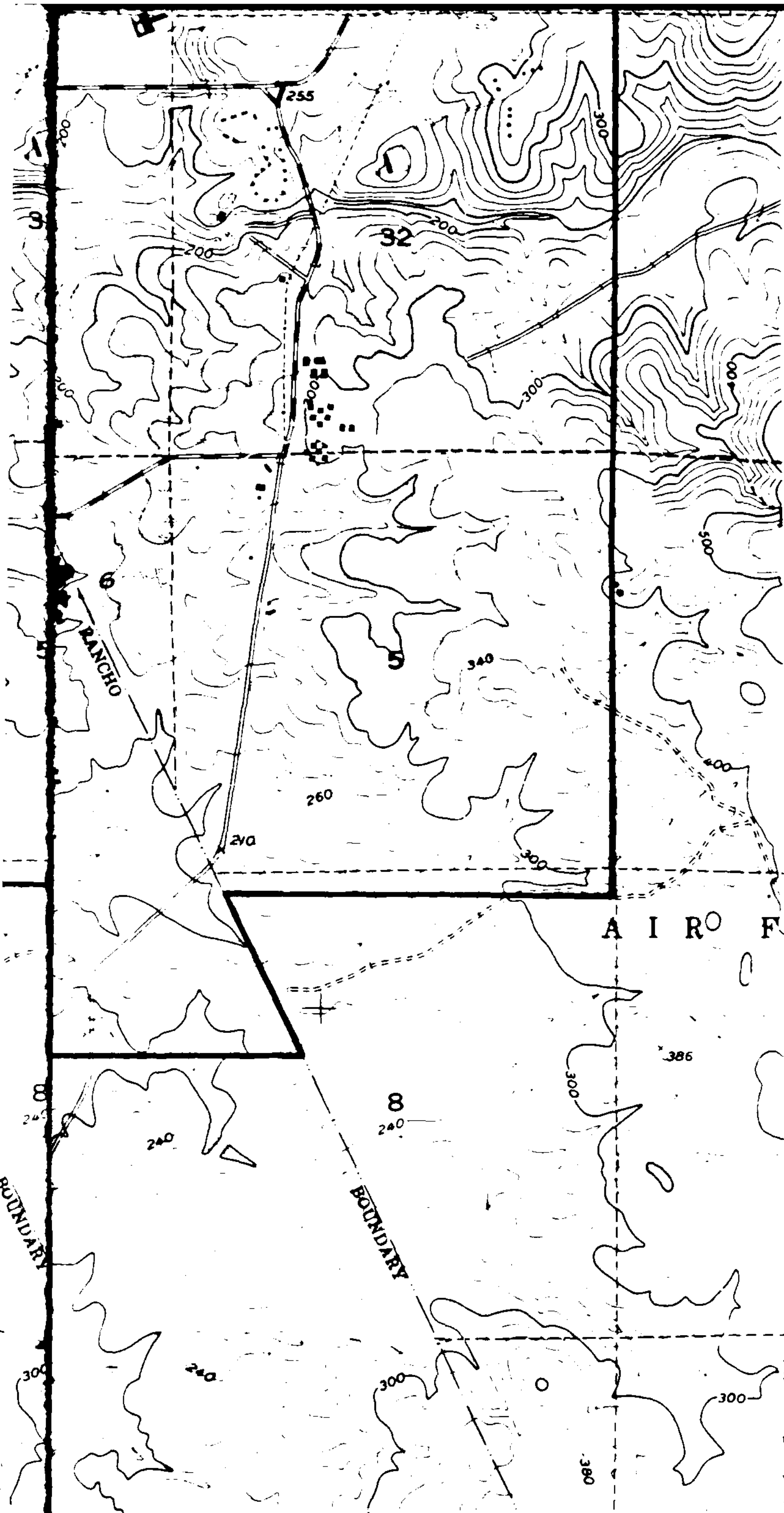


Figure I-3

Base Map

Beale Air Force Base

AeroVironment Inc.

2. Photo Wastewater Treatment Plant and Injection Well No. 2

The Photo Wastewater Treatment Plant (PWTP) has been used since 1966 to treat wastewater from the base's reconnaissance photo lab. It is located on the southwest corner of the base, adjacent to the sewage treatment plant. No photo wastewater was generated before 1966. Starting in 1967, sludge was dried in concrete drying beds and disposed of in Landfill 2. In 1974, two earthen-lined sludge ponds were constructed and used during the winter months. This practice was continued until 1978, when the concrete beds were abandoned and the earthen-lined ponds were used year round. From 1967 until 1984, whenever the treatment plant was shut down for maintenance, 500 to 2,000 gallons of effluent treated with pentachlorophenol were discharged onto the ground in the vicinity of the injection wells. This procedure was carried out 12 times a year to flush out any corrosion in the lines. In 1984, this procedure was terminated at the request of the California Regional Water Quality Control Board (CRWQCB).

In February 1984, the CRWQCB took soil samples for pentachlorophenol near Injection Well No. 2 and adjacent to the sand filters at the plant. Results showed that levels complied with California standards (Engineering Science, 1984).

3. Fire Protection Training Areas Nos. 1 and 2

Fire training exercises have been conducted at Fire Protection Training Areas (FPTAs) Nos. 1 & 2 since 1958. Because they are located within 200 feet of each other, they have been combined for evaluation.

From 1958 to 1971, the fire department conducted live fire training exercises at FPTA No. 1. This site is located in the half acre adjacent to the intersection of J and 27th Streets. Until the late 1960s, combustible waste chemicals were accumulated in a shallow two-foot-deep basin in the FPTA. These chemicals were reported to have included waste oils, spent solvents, and jet fuel. These chemicals were burned weekly in the basin. Other chemicals were accumulated in 55-gallon drums and burned in the same basin. The basin area did

not have a liner, nor was there any preapplication of water to prevent the percolation of the waste chemicals into the soil. The materials were applied directly to the soil and ignited (Engineering Science, 1984).

FPTA No. 2, 200' west of FPTA No. 1, was put into operation in 1972, when use of FPTA No. 1 was discontinued. This operation burned only contaminated jet fuel on an area that had first been saturated with water.

There are two 25,000-gallon underground storage tanks located at FPTA No. 2. The tanks are designated as the "north tank" and the "south tank." The north tank contains jet fuel that is used by the base Fire Department for live fire training in the adjacent fire pit. The south tank has traditionally contained contaminated (dirt, oil, etc.) fuel, hydraulic fluid and waste solvents. Underground fuel lines run from the tanks to the fuel nozzles at the airplane mock-up in the fire pit.

The only recorded spill incident at the FPTA occurred in May 1983. Water from the north tank was inadvertently pumped out of the tank and onto the ground. The intent was to provide additional tank capacity for a leak check of the tank. Three months previous to this event, the base BEE shop had analyzed to contents of the north tank (through lab facilities at USAF OEHL) and reported that the north tank liquid contained lead and chromium levels of 10 and 5.5 mg/l, respectively. The discharge of this liquid onto the ground subsequently created concern about soil contamination with lead and chromium. Appropriate regulatory agencies were notified of the spill. Follow-on soil testing by the BEE did not indicate the need for any remedial action.

4. Discharge Area No. 2 (Battery Shop Dry Well)

From 1972 to 1983, approximately 24 gallons per month of neutralized battery acid were discharged to this dry well, which is located adjacent to the Battery Shop (Building 1088). The discharge may have had high lead concentrations.

5. Discharge Area No. 3 (SR-71 Shelter)

Since 1966, the ground operation of the SR-71 aircraft has resulted in about 300 gallons per week of JP-7 being dripped/leaked onto the hangar floors and parking apron area. Some of the fuel flows with wastewater from wash-down activities and rain onto the soil adjacent to hard-surfaced areas.

6. Landfill No. 2

This 56-acre landfill, located just south of 6th Street near its intersection with Earle Road, was used primarily for refuse disposal from the early 1950s until 1980. Between 1967 and 1978, about 380 cubic yards of dried sludge from the Photo Wastewater Treatment Plant were disposed of here. Small amounts of chemicals are also known to have been discarded.

7. Discharge Area No. 4 (Army Biological Production Site)

The Biological Test Site, located adjacent to the current Base Rod and Gun Club, was used by the U.S. Army to produce wheat stem rust from 1962 to 1969. During production, the chemicals used on site included Freon, carbon dioxide, ethylene oxide and possibly TCE. In 1969, production stocks of wheat stem rust were chemically treated, incinerated and the ash plowed into the soil on the site. The Army has indicated that the site has been decontaminated.

8. Discharge Area No. 6 (J-57 Test Cell Drainage Ditch)

The J-57 Test Cell, located adjacent to Building 1247, receives runoff from the test stand used to test aircraft engines. Chemicals discharged include JP-4, PD-680 and soap. Shop personnel estimate that these discharges have been occurring since 1958 but can only confirm their occurrence since 1966.

9. Discharge Area No. 9 (Entomology -- Building 2560)

The Entomology shop is responsible for pest control on the base. Since 1981, rinsate from pesticide application equipment has been discharged onto a gravel area just outside Building 2560.

10. Discharge Area No. 5 (J-58 Test Cell Drainage Ditch)

The J-58 Test Cell, located adjacent to Building 1154, has been routinely used to test the SR-71 jet engines since 1959. Wastes that may have run off into the drainage channel include JP-7, soap, oil, TCE and PD-680.

11. Discharge Area No. 7 (AGE Maintenance/Drainage Ditch)

Aircraft ground support vehicles parked on a paved area adjacent to AGE (Aircraft Ground Equipment) Maintenance at Building 1225 leak oil and hydraulic fluids. This operation has been located here for 25 years, and runoff of oil and fluids is known to have occurred since 1970, and discharges may have occurred as early as 1958. A drainage ditch located behind Building 1225 (AGE Maintenance) shows evidence of having received fuel and oil-contaminated runoff. Some restoration of the area and stained soil excavation occurred in 1984.

12. Discharge Area No. 10 (Entomology -- Building 440)

The area surrounding Building No. 440 may have been exposed to pesticide/herbicides from 1965 to 1980 since this site was used to store and mix pesticides used on the base. The building is currently used by the base's animal control personnel.

13. Landfill No. 1

This 4-acre landfill is located in the southwestern sector of the base, approximately 1000 feet west of the wastewater treatment plant. It received refuse during the 1940s, but the source and composition of the refuse is unknown.

14. Discharge Area No. 8 (Transformer Drainage Area)

The transformer drainage area is located adjacent to 34th Street near B Street. From 1977 to 1979 transformers were drained in this diked area before being taken into the shop for repair. Eleven of twelve soil samples collected by base personnel in 1984 indicated PCB concentrations below the detectable limit of 0.5 mg/kg (ppm); however, one sample contained 14 mg/kg (ppm) of PCB.

15. Landfill No. 3

This 40-acre landfill, situated east of Landfill No. 2 and adjacent to 6th Street, was opened in 1981 and is currently in use. It is permitted as a Class III landfill by the California Regional Water Quality Control Board. Waste deposited here is domestic garbage and refuse.

The following three sites were added to the IRP Phase II investigation after the Phase I records search. Information on these sites is limited.

16. Explosives Ordnance Disposal Area

The Explosives Ordnance Disposal (EOD) Area is a 70-foot long, 20-foot wide trench located on the northern sector of the base at the EOD range. It is used for the disposal of spent demolition waste, flares and pyrotechics. After burning, remains are inspected and unburned ammunition is removed; the burned portion is disposed in the trench. Base personnel working at this site report that the operation has been unchanged for at least five years.

17. Best Slough

The Best Slough was added to the IRP list because old drums were discovered in a 50-100 ft trench near the three bridges area on Gavin Mandry Road in January 1985. No information is available on what, if anything, was in the drums or when they were dumped.

18. Bulk Fuel Storage

The bulk fuel storage area is located on the northeast side of the intersection of 6th Street and J Street. It has been in use since 1958 and was evaluated because suspected area contamination from fuel storage and management activities. Beale's petroleum-handling system includes substantial volumes of jet fuel (JP-4, JP-7, JPTS), diesel fuel, motor gasoline (MOGAS), unleaded gasoline and No. 2 fuel oil. Fuels are delivered by pipeline, train or truck to large cylindrical above-ground storage tanks. Jet fuels (JP-4 and JP-7) are pumped via pipeline to a flightline dispensing system for refueling aircraft. Trucks are also used to refuel aircraft. No major spills have occurred to create potential for contaminant migration.

E. Identification of Laboratory Parameters

Samples from 14 of the sites were tested for volatile organic compounds (VOC) and oil and grease (O&G). Specific analyses were performed for constituents known or suspected at four sites; i.e., Entomology Shops (pesticides/herbicides), Transformer Drainage (PCBs), and EOD (explosive compounds). Generally, sites likely to have had fuel spills or leaks were also tested for petroleum hydrocarbons and total phenols. Analyses for lead or heavy metals were performed if leaded fuels had been used. Landfills were tested for pesticides/herbicides, phenols and metals, in addition to VOC and O&G. Usually, soils and water samples from the same site were analyzed for the same parameters. Table I-2 shows the specific parameters analyzed for each site.

F. Identification of Field Team

The field investigation team AV assembled for the Phase II, Stage 1 study at Beale AFB included AV personnel, a drilling subcontractor and a geophysical subcontractor. The AeroVironment team included the following professionals:

TABLE I-2. Analytical requirements for soil and water samples.

Site No.	Site Name	Parameters for Water Samples	Parameters for Soil/Sediment Samples
1	West Drainage	VOC (601/602) O&G (413.2) Heavy Metals Phenols (Total)	VOC (8010/8020) O&G Heavy Metals Phenols (Total) Pesticides/Herbicides (509A,B)
2	Wastewater Injection Wells	VOC O&G Heavy Metals B/N/A (625)	VOC O&G B/N/A
3	FPTA	VOC O&G Petroleum Hydrocarbons (418.1) Phenols (Total) Lead	VOC O&G Petroleum Hydrocarbons Phenols (Total) Lead
4	Battery Shop	VOC O&G Heavy Metals Phenols (Total)	VOC O&G Heavy Metals Phenols (Total)
5	SR-71	VOC O&G Phenols (Total)	VOC O&G Phenols (Total)
6	Landfill No. 2	VOC O&G Heavy Metals Pesticides/Herbicides Phenols (Total)	--
7	Biological Production	--	VOC Heavy Metals w/Extraction (EP Tox)
8	J-57 Test Cell	VOC O&G Petroleum Hydrocarbons Phenols (Total)	VOC O&G Petroleum Hydrocarbons Phenols (Total)
9	Entomology Building 2560	--	Pesticides/Herbicides

O&G = Oil and Grease Analysis
VOC = Volative Organic Analyses
B/N/A = Base/Neutral/Acid organic analyses

TABLE I-2. (Continued)

Site No.	Site Name	Parameters for Water Samples	Parameters for Soil/Sediment Samples
10	J-58 Test Cell	VOC O&G Petroleum Hydrocarbons Phenols (Total)	VOC O&G Petroleum Hydrocarbons Phenols (Total)
11	AGE Maintenance	VOC O&G Phenols (Total)	VOC O&G Phenols (Total)
12	Entomology Building 440	--	Pesticides/Herbicides
13	Landfill No. 1	VOC O&G Heavy Metals Pesticides/Herbicides Phenols (Total)	VOC O&G Heavy Metals Pesticides/Herbicides Phenols (Total)
14	Transformer Drainage	--	O&G PCBs (608)
15	Landfill No. 3	VOC O&G Heavy Metals Phenols (Total)	--
16	EOD	--	Heavy Metals Explosives Scan
17	Best Slough	VOC O&G Pesticides/Herbicides Phenols (Total)	VOC O&G Pesticides/Herbicides Phenols (Total)
18	Bulk Fuels Storage	--	VOC O&G Petroleum Hydrocarbons Phenols (Total) Lead

Mr. Douglas Taylor, P.E., is a project manager in AV's Environmental Programs Division. He has a Master of Engineering in environmental engineering and six years' experience in hazardous waste management and site assessments. He has managed numerous DoD, EPA, and private party site investigations and sampling programs. As project manager for the Beale study, he was the main interface between AV and USAF OEHL and was responsible for the scheduling of field work (drilling and sampling), for the management of drilling and laboratory subcontractors, and for personnel staffing and technical review.

Mr. Timothy O'Gara is the leader of AV's Earth Sciences Section. He holds a B.A. in earth science and has six years' experience in groundwater monitoring and hazardous waste investigations. Mr. O'Gara has directed drilling, well installation and soil sampling programs at sites throughout California. At Beale, he was responsible for directing the well-drilling program. His duties during this project included coordinating with base personnel, selecting well locations, supervising the drilling crews, and reporting on hydrology.

Mr. Christopher Lovdahl, an environmental chemist at AV, holds a B.S. in environmental science and has six years' experience in environmental compliance, waste site sampling and analytical chemistry. He worked for four years at industrial facilities and analytical laboratories prior to his IRP involvement. At Beale, Mr. Lovdahl was responsible for reviewing well sampling requirements and coordinating with the laboratories. He served as the point of contact between AV and the analytical chemistry laboratory at Acurex, instructing Acurex on selected methods and special handling. He also performed QA/QC reviews on all laboratory data.

Mr. John Miller, a geochemist at AV with an M.Sc. in geochemistry, has eight years' experience in geology and geochemistry in the mining and mineral processing industries. He has worked extensively with soil sampling, laboratory analysis and quality assurance. Mr. Miller served as a field geologist during the well drilling program. He was responsible for logging the samples and designing the wells. He was also active in the QA/QC review of laboratory data.

Ms. Sheryl Thurston, an environmental engineer at AV with a B.S. in environmental engineering, has one year of experience with IRP programs and state RCRA recordkeeping. She served as a field engineer during well drilling at Beale and assisted with driller supervision and sample logging. She was also part of the sampling team and conducted research on base operations and environmental setting.

Complete resumes of the AV personnel mentioned above are included in Appendix I.

AeroVironment also used Mr. John Keating of Gregg and Associates Inc. to assist in well installation and hole logging. Mr. Keating holds a B.S. in geotechnical engineering and has three years of experience with groundwater well drilling and geologic logging.

The Water Development Corporation (Water Development) of Woodland, California, performed the drilling. Water Development has 35 years' experience in drilling water production and monitoring wells at locations throughout California. The company and many of its personnel have specific experience drilling in the Sacramento area and working on IRP programs at other Air Force bases. Water Development provided a D40K Drilteck air rotary drilling rig equipped with a casing hammer and support equipment, with which it drilled, constructed and developed all 20 wells under the direction of AeroVironment field personnel.

Geophysical surveys were conducted at Landfill No. 1 by the Converse Consultants Inc. (Converse) of San Francisco, California. Converse is a highly respected geotechnical consulting firm with over eight years' experience in geophysical investigations. The surveys were completed under the direction of Mr. George Ford (B.S., Geology, Certified Engineering Geologist and Registered Geologist) of Converse. The ground-penetrating radar was performed by Mr. Richard Lee (M.S., Geophysics) of Harding Lawson Associates under the direction of Converse. Mr. Timothy O'Gara of AV coordinated this activity.

Laboratory work was performed by Acurex Corporation (Acurex) of Mountain View, California. Acurex's Energy and Environmental Division joined with AeroVironment as part of the contract team for USAF OEHL. Mr. Gregory Nichol (M.S., Chemistry, eight years' laboratory management experience) served as program manager for the Acurex effort on this task.

Analytical Research Laboratories, Inc. (ARLI) of Monrovia, California, performed the explosive scan testing of EOD samples. Dr. Gerald Delker (Ph.D. Chemistry) coordinated the method research and testing. This lab has since changed its name to Thermo Analytical Inc.

II. ENVIRONMENTAL SETTING

A. Physical Geography

Beale AFB is situated on the eastern flank of the Sacramento Valley, a subdivision of the Great Central Valley. The Great Central Valley is about 60 miles wide and 400 miles long and extends from Bakersfield, California, in the south to Red Bluff, California, in the north (Figure II-1). The Sacramento Valley occupies the northern 150 miles and averages about 30 miles in width.

The Great Central Valley is one of the major structural depressions of the world, containing up to 30,000 feet of Cretaceous and Cenozoic sediments. Currently, the Sacramento Valley consists of a few rivers and many ephemeral streams, all of which have very large floodplains, reflecting infrequent but often heavy precipitation.

1. Topography

During the Pleistocene, the Sacramento Valley consisted of dissected uplands, low alluvial fans and plains, and floodplains. Braided streams (i.e., multiple channel streams) crisscrossed the alluvial plains splitting the lowlands into numerous island-like tracts. The recent (Holocene) climate is drier, so streams carry less sediment and are more often restricted to a single channel with meanders rather than braiding. During this period, topographic features have remained relatively unchanged or have become more pronounced with time.

Beale AFB sits astride the physiographic boundary between the Sierra Nevada foothills and the Sacramento Valley and thus contains a wide range of geomorphology, geology and topography (Figure II-1). Surface drainage is principally from the northeast (Sierra Nevada Mountains) to the southwest (Feather River). At the Feather River, surface flow shifts to a southerly direction and continues on down the Sacramento River to the confluence with the northward-flowing San Joaquin River, from which the combined flow proceeds westward to San Francisco Bay.

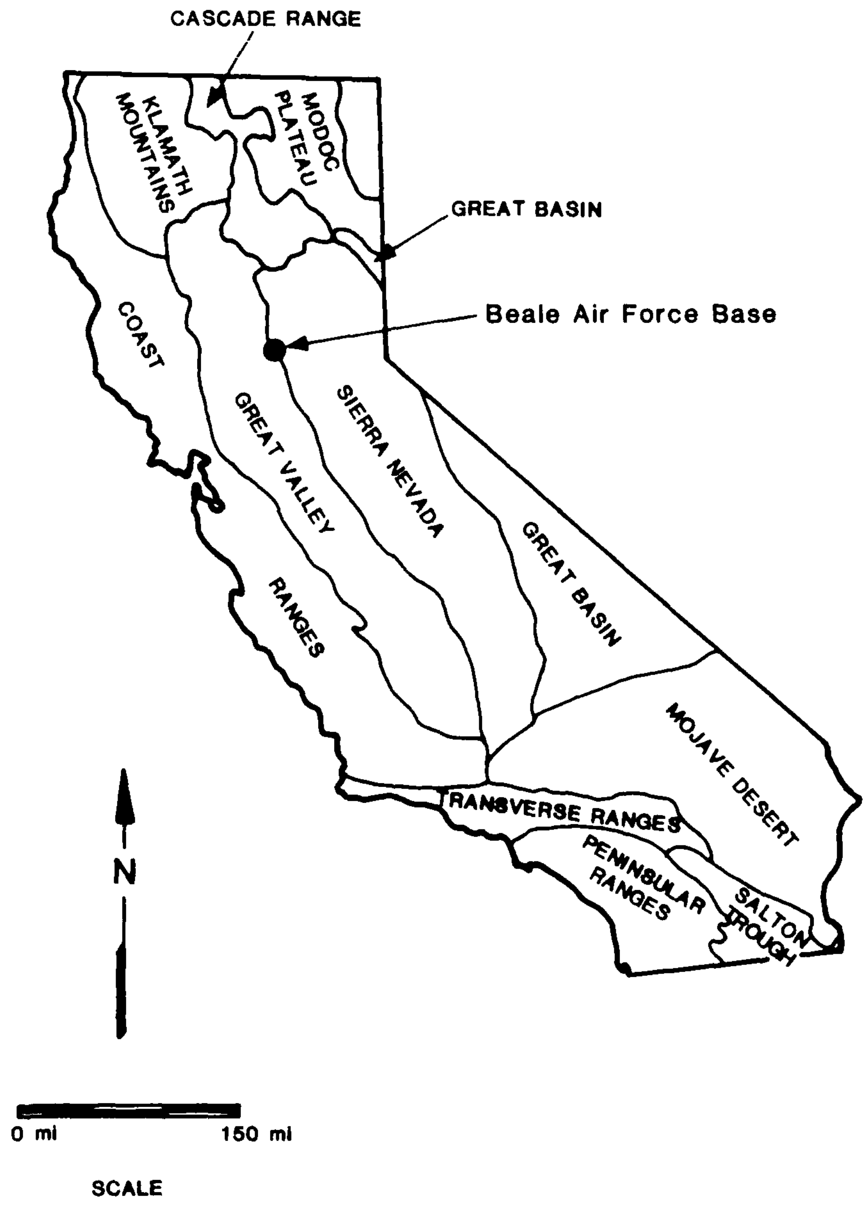


Figure II-1
Physiographic Provinces of California
Beale Air Force Base
AeroVironment Inc.

Source: California Division of Mines and Geology, 1969

The western portion of Beale AFB is typically flat (80 to 125 feet MSL) and consists of a floodplain and small, often ephemeral, meandering or braided streams. Most of AeroVironment's work was performed in this area.

As one moves eastward, streams become better defined and the terrain quickly evolves into dissected uplands with readily visible relief. This terrain (125 to 200 feet MSL) forms the eastern boundary of the Sacramento Valley and comprises about fifty percent of Beale AFB. Most groundwater recharge occurs here and along the Yuba River. The dominant geologic units are tertiary water-worked volcanics and, to a lesser extent, the Quaternary Laguna Formation. AeroVironment performed a small amount of work in this terrain.

2. Soils

Beale AFB contains four different soil associations, which reflect the underlying geologic units that are the soils' parent materials. Figure II-2, taken from a Yuba County soil map by Herbert & Begg (1969), shows the soils at Beale AFB. A more detailed soil map with excellent air photo coverage was prepared by the USDA Soil Conservation Service in 1985. However, the final version of this report is still to be published.

The western third of the base is underlain by the Yokohl-Kimball Association, which formed on moderately old alluvial fans. The soils consist of poorly drained, medium-textured clay and hardpans developed on Victor Formation (Qv). (Note: Qv is a geologic coding that identifies the age of the rock and its formation.)

The midsection of the base contains a strip of soil known as Redding-Corning, which is oriented northwest to southeast. The soil is usually gravel rich with hardpans and claypans. Generally, it overlies the Laguna Formation (Qtl) and Mehrten Formation (Pv). Surface infiltration is moderate, but subsurface infiltration is slow, because the hardpan retards vertical water movement.

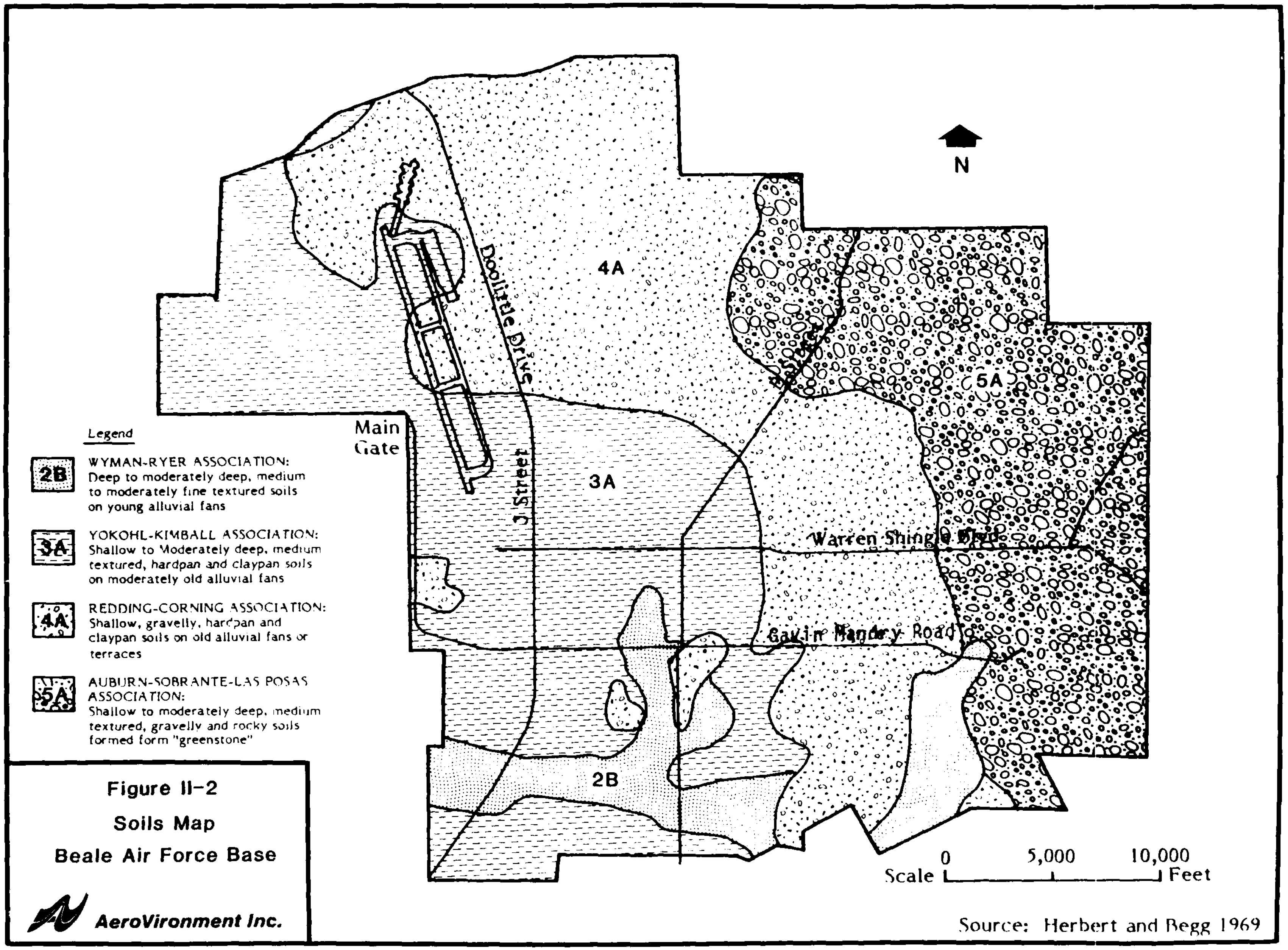


Figure II-2
Soils Map
Beale Air Force Base

Reference: Engineering Science, Phase I IRP Report, April 1984

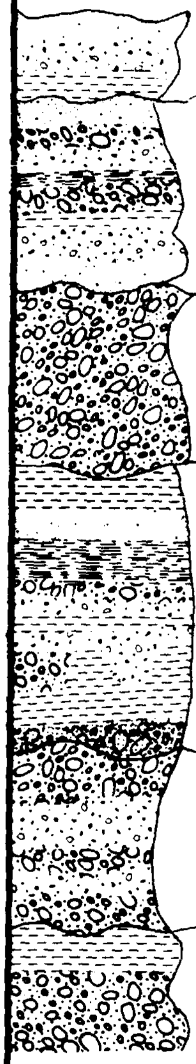
The Auburn-Sobrante-Las Posas Association occupies the eastern portion of the base and is associated with the Sierra Nevada pretertiary basement complex (Pt). It is a shallow, gravelly, and rocky soil formed on decomposing metamorphic, igneous and sedimentary rocks. It is a relatively immature soil, due to the high relief and rapid erosion of the Sierra Nevada.

B. Regional Geology

The stratigraphy and surficial geology discussed below is taken from the work of Page (1974, 1980) and that of Olmsted and Davis (1961). A schematic of the general stratigraphy at Beale Air Force Base is provided in Figure II-3.

Moving from west to east across Beale AFB, one generally encounters progressively older lithologies. In addition, the overall grain size tends to increase and the gravel more and more reflects the Sierra Nevada volcanics and the metamorphic, igneous basement complex. However, one depositional type, quaternary river deposits (Qr), is an exception to this general rule. The Qr of Holocene deposits are the youngest deposits, present-day sediments deposited by drainages such as Hutchinson, Best and Dry Creeks. These deposits are generally only a few feet or tens of feet thick and are mapped by Page as overlying virtually all other formations in areas adjacent to these drainages.

The eastern thirty percent of Beale AFB lies within the Sierra Nevada foothills. The contact between the Sacramento Valley and the Sierra Nevada foothills is geologically defined by pretertiary, metamorphic, igneous and sedimentary rocks belonging to the Sierra Nevada physiographic province. This contact may be crudely approximated by the 200-foot elevation contour. The rocks of this province are considered to be basement (i.e., the lowest and hence oldest rocks exposed in the region). The basement complex slopes to the southwest at two to six degrees, with a maximum of 1,400 feet of posttertiary cover underlying Beale AFB. Little groundwater is found in this terrain and AeroVironment did no work in this area of Beale.



Holocene: (recent) symbol: Qr	Unconsolidated river and stream deposits from current drainage system (0-20 feet). Mostly silt clay and sand; minor gravel.
10' - 20'*	UNDULATORY CONTACT
Victor Formation: (Quaternary) symbol: Qv	Heterogeneous fluviatile clay to gravel sediments. Extremely lenticular deposits from braided streams. Mostly silty sand.
85' - 120'	UNDULATORY CONTACT
Quaternary Gravels: (Quaternary)	Discontinuous gravel layer or lenses (0-50 feet) at base of Victor. Occasionally present at Beale, tends to form hills. Included with Laguna Formation in cross sections.
	UNDULATORY CONTACT
Laguna Formation: (Pleistocene to Pliocene age) symbol: Qtl	Heterogeneous to poorly sorted silt, sand and clay with thin gravel units comprised of silt and clay with fine sand. Approximately 0-120 feet thick.
120' - 140'	UNDULATORY CONTACT
Laguna-Mehrten Transition (Pliocene): symbol: Ptl	Thin to moderate (0-40 feet), locally absent, gravel and/or coarse sand at base of Laguna. Gravel generally angular and dark (mafic) colored. Minor to moderate silt/clay.
130' - 150'	EROSIONAL CONTACT
Mehrten Formation (Miocene Pliocene): symbol: Pv	Volcanic derived angular gravels and sand: dark mafic rock fragments; mudflows. Discontinuous with abundant cross bedding and cut-and-fill structures. Thickness approximately 200 feet. Formation top clay derived from mafic gravels.

* Typical depths found at Beale AFB during Phase II, Stage 1 drilling.

Figure II-3

Typical Stratigraphic Section

Beale Air Force Base

AeroVironment Inc.

Most of AV's drilling was conducted in either the Victor (Qv) or the Laguna (Qtl) Formations. Several drill holes penetrated the Mehrten (Pv), a thick, multicolored clay. Elsewhere, the contact between formations was difficult to locate.

At Beale, the formation of primary interest is the Laguna because most water production wells in the area are completed in or very close to the basal Laguna that hosts the uppermost aquifer. In areas where the Laguna-Mehrten transition zone is present just below the Laguna Formation, this zone is a good water producer for monitoring wells (e.g., Site No. 11). However, its variable thickness (0 to 40 feet) and absence in some areas (e.g., Site No. 3, FPTA) makes it an undesirable aquifer for high-volume wells.

C. Regional Hydrogeology

Groundwater movement has historically been from the Sierra Nevada Foothills eastward to the Feather and Sacramento Rivers. Until the early part of this century, the river system served as a groundwater discharge system. Extensive farming and irrigation rapidly lowered the water table and altered the direction of flow, thus changing the river from a discharge to a recharge system. Additional recharge is permitted by coarse deposits along the Sierra Nevada Foothills. These deposits allow seasonal rainfall/snowmelt to percolate downward.

Regional groundwater contours for the Beale area are shown in Figure II-4. The most obvious feature is the area of intense drawdown southwest of the base boundary caused by irrigation pumping. Between 1945 and 1974, the water table fell about 60 feet and then stabilized in the mid-1970s. However, between 1977 and 1980, the water table declined sharply once more, in response to drought and increased irrigation for rice production (Engle, 1986). Since 1980, the water level has risen markedly, as a result of increased precipitation and lower rice production. Nevertheless, the overall drawdown has been sufficient to alter the direction of local flow in the area of the base well field from west to nearly south. The location of existing base wells is shown in Figure II-5.

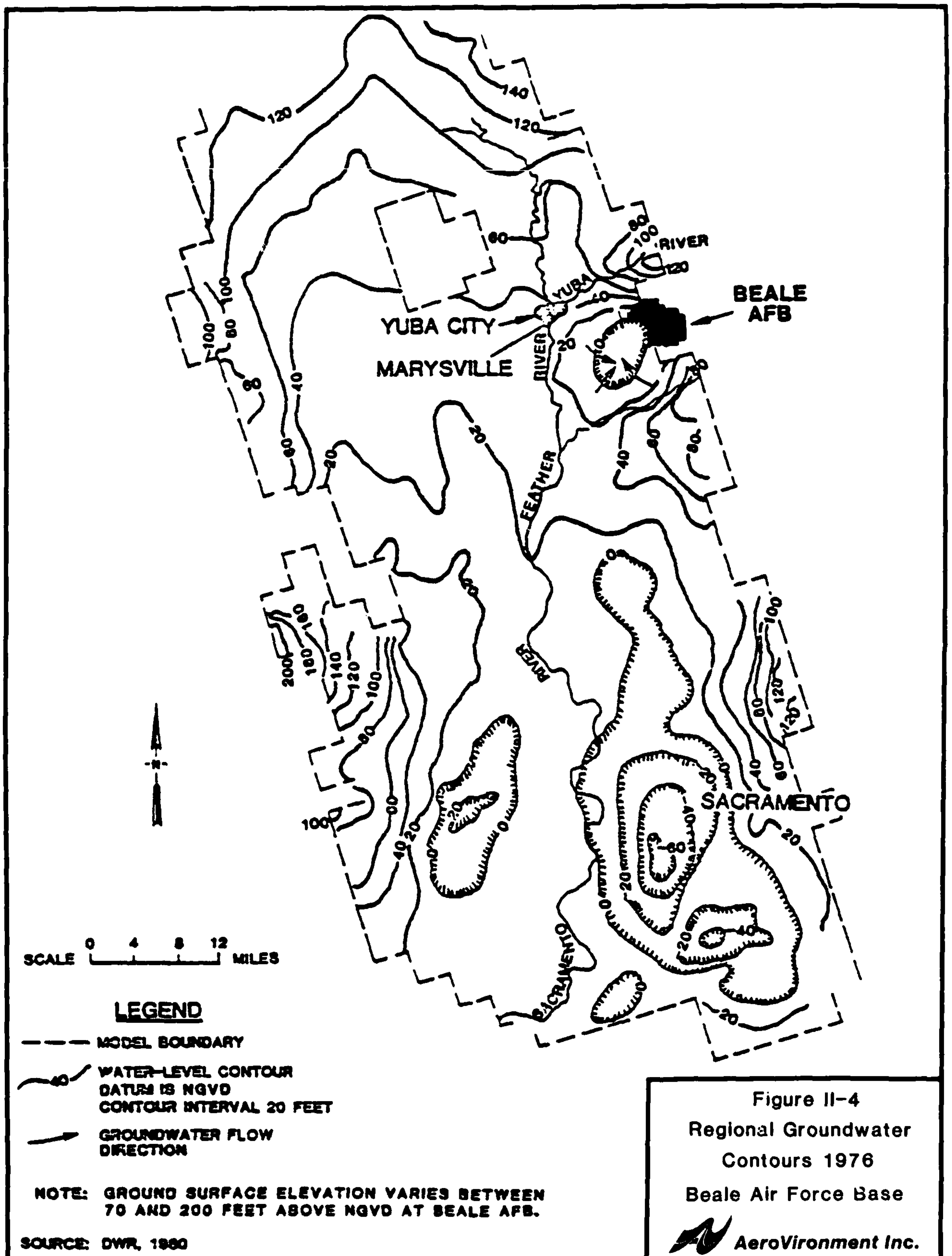


Figure II-4
Regional Groundwater Contours 1976
Beale Air Force Base

AeroVironment Inc.

Reference: Engineering Science, Phase I IRP Report, April 1984

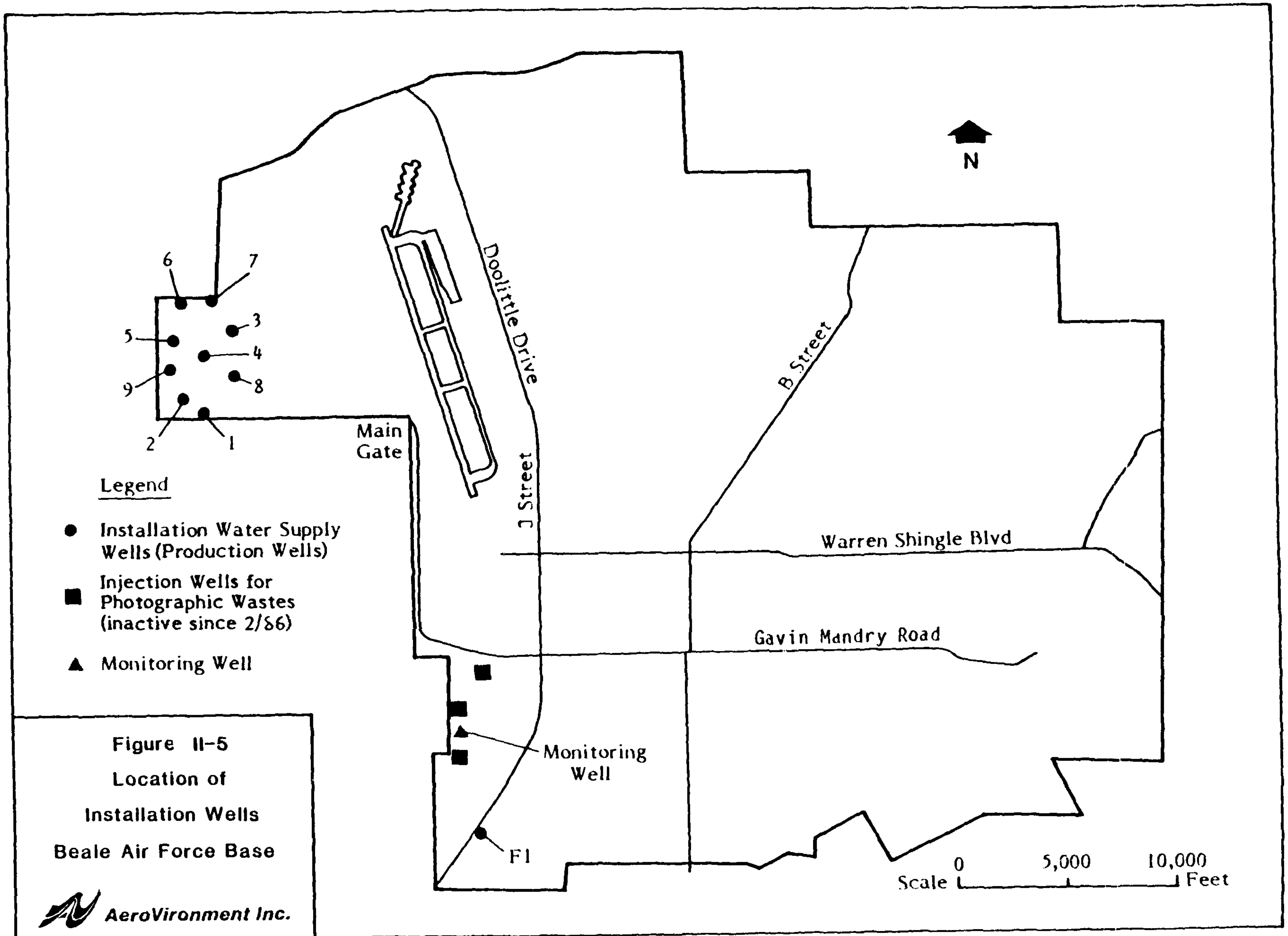


Figure II-5
Location of Installation Wells
Beale Air Force Base

Reference: Engineering Science, Phase I IRP Report, April 1984

Off-base irrigation and domestic wells on the west and south sides of Beale are shown in Figure II-6. Water levels for these wells, obtained from Mr. D. B. Engel of the Yuba County Agricultural Commission, show an upward trend from 1984 through 1985. The heavy rains of 1985-1986 should insure that the water table will continue to rise throughout 1986.

Studies by Rockwell (1978) and Page (1980) assumed that groundwater tapped by the base wells is basically unconfined except where local clay/silt lenses cap the aquifer to produce semiconfined conditions. Thus the fresh water base occurs at a depth of 300 to 500 feet, coinciding with the base of the undifferentiated sedimentary rocks.

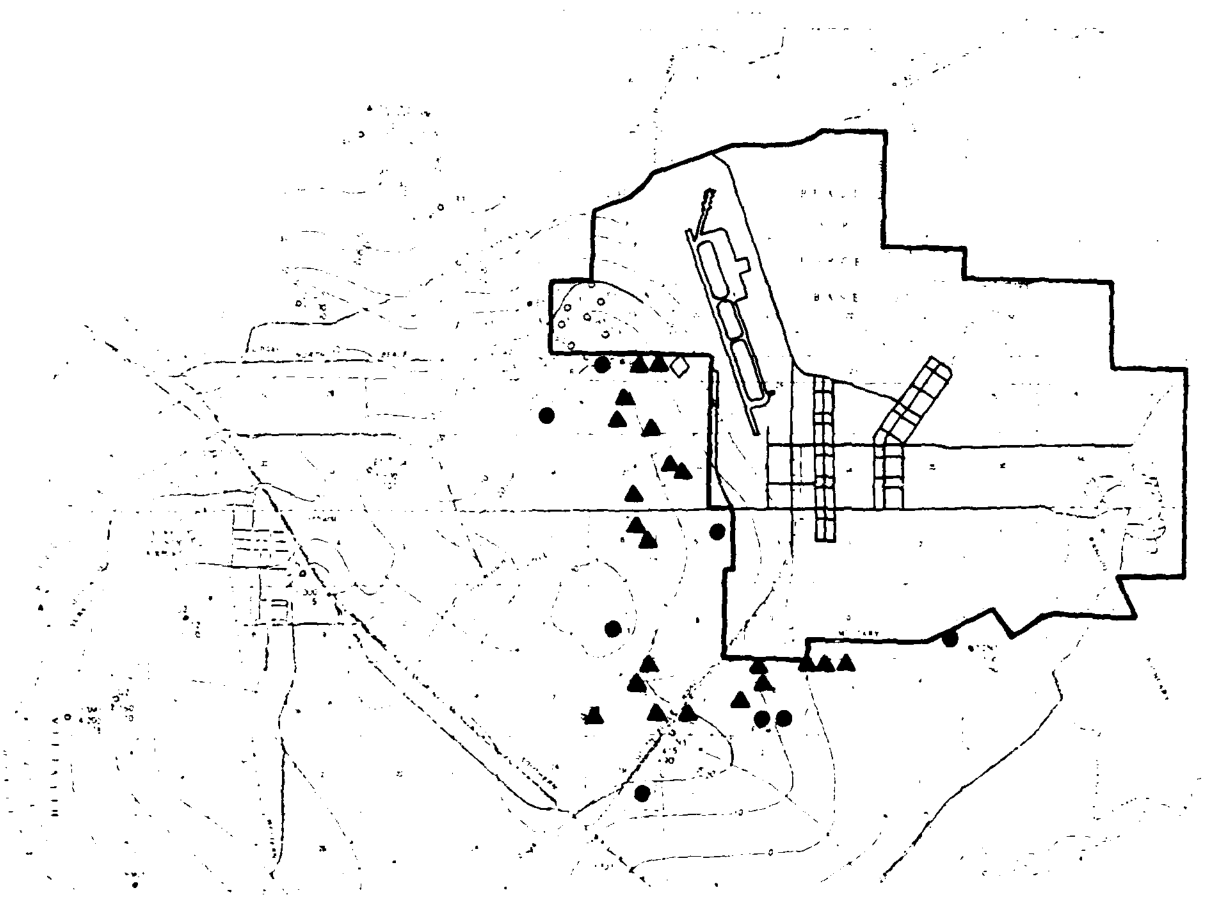
D. Site Descriptions*

Site 1. Discharge Area No. 1 (West Drainage Ditch)

Discharge Area No. 1 (West Drainage Ditch) is a drainage system which drains the flightline and surface runoff from the runway area. The drainage system discharges through a headwall located about 800 feet west of the main runway and into a ditch which is filled with vegetation. Oil absorbent booms have been placed immediately downstream from the headwall. Past surface water quality data indicated oil and grease and trans-1,2 dichloroethene in the water discharged to this ditch. Visual observations indicate that oils have accumulated in the soils of the ditch adjacent to the headwall.

The West Drainage ditch begins less than 1,000 feet from the base boundary. Occasionally, during the wet season (from October through April), water from the ditch flows off base, presenting the potential for environmental contamination outside the base boundary. The site is also less than one mile from off-base groundwater users. Surface soils in the area are medium-textured hardpan and claypan, which have a characteristically low permeability; thus they would restrict percolation of water and any contaminants.

*The information presented in this section was taken from the Engineering Science Phase I IRP Report and on-site observations interviews during Stage 1.



N

Scale 0 2 Miles

Legend

● Domestic Wells
▲ Irrigation Wells
◇ Unknown Use

Source: Rockwell, 1978, Page, 1980, Yuba County Agricultural Commission

Figure II-6

Location of Area Wells

Beale Air Force Base

AeroVironment Inc.

Reference: Engineering Science, Phase I IRP Report, April 1984

Site 2. Photo Wastewater Treatment Plant and Injection Well No. 2

The Photo Wastewater Treatment Plant (PWTP) has been used since 1966 to treat photo wastes. It is located on the southwest portion of the base and receives wastes from the photo laboratory (Building 2145) 2.5 miles to the northwest. Average waste flow is 20,000 gpd. Treatment and processes include equalization, chemical flocculation, settling, and filtration. Three injection wells were used for PWTP effluent disposal until injection was discontinued in April 1986. Four groundwater monitoring wells were installed around the Photo Waste Sludge Pond in 1985 by Radian Corporation. These wells are used to monitor for evidence of contamination from the earthen-lined ponds.

The concern at Site 2 results from the unlined pond and the occasional discharging of treated PWTP effluent onto the ground near the well heads. This site (plant and injection wells) is approximately 500 feet from the base boundary and less than 500 feet from Hutchinson Creek. Soils are medium-textured hardpan that have low permeability and, therefore, retard vertical movement.

Site 3. Fire Protection Training Areas Nos. 1 and 2

Fire-fighting exercises were conducted at Fire Protection Training Area (FPTA) No. 1 from 1958 to 1971 and have been conducted at FPTA No. 2 since 1972. The two sites have been combined for this investigation because of their proximity. FPTA No. 1 is located in the half-acre adjacent to the intersection of J and 27th Streets. It contained a shallow, two-foot-deep, unlined basin. There is no visual evidence of the old FPTA No. 1. FPTA No. 2 is located about 200 feet west of FPTA No. 1. It consists of a shallow basin 150 feet in diameter surrounded by a 12-inch berm. Inside the basin is a mock aircraft used for fire training exercises. About 100 feet south of the mock aircraft is an unlined 100-foot-square basin designed to hold the liquid which runs off of FPTA No. 2. Fire training exercises involve simulated full fires in and around the mock aircraft and is intended for firefighter training. Residual fuel and water is left in the unlined basin.

The site is located within 1 mile of the base boundary. Surface soils contain a layer of hardpan, which has very low permeability and retards vertical contamination.

Site 4. Discharge Area No. 2 (Battery Shop Dry Well)

A sink drain in Building 1088, used to dispose of rinsate after acid is drained into containers from lead acid batteries, was connected into a dry well. The "dry well" was four feet in diameter and approximately 20 feet deep and filled with cobbles. The neutralized acid could have high concentrations of lead. Use of the dry well was discontinued in 1983.

Site 5. Discharge Area No. 3 (SR-71 Shelter)

The SR-71 aircraft is so constructed that it will leak JP-7 while on the ground. It has been estimated that the planes lose about 300 gallons of fuel per week. A major portion of the fuel is lost in the vicinity of the SR-71 shelters and on Taxiway No. 10 east of the shelters. Some of the fuel runs off the taxiway into an oil-water separator. Another portion of the fuel runs off into the adjacent storm sewer which is upstream of DA-1. The soils adjacent to the taxiway area are discolored in areas indicating potential contamination.

Site 6. Landfill No. 2

Landfill No. 2 occupies 56 acres in the southern sector of the base. It was used primarily for refuse disposal from the early 1950s until 1980. Between 1967 and 1978, about 380 cubic yards of sludge from the Photo Wastewater Treatment Plant were disposed of here. Small amounts of chemicals and petroleum were also discarded here. Landfill No. 2 is currently used to dispose of dirt, wood and other construction and grounds maintenance debris.

Site 7. Discharge Area No. 4 (Army Biological Production Site)

During the period 1962 to 1969, the U.S. Army produced wheat stem rust at the biological test site located adjacent to Building 1154, in the southwest corner of the base. In 1969, the production stocks remaining at Beale were destroyed and the material was rendered inactive by carboxide treatment and incineration. The residual ash was assayed and plowed into the soil at the site to a depth of six inches. The entire destruction process was accomplished successfully, in complete cooperation with federal and state agricultural authorities. The only chemicals used at the site were Freon, carbon dioxide, ethylene oxide and possibly TCE.

The site is currently used as the Base Gun Club. Game birds are housed in large pens throughout the site.

Site 8. Discharge Area No. 6 (J-57 Test Cell Drainage Ditch)

The J-57 Test Cell is located adjacent to Building 1247 at the north end of the flightline. The drainage ditch at the test cell receives runoff from the test stand used to test aircraft engines. The runoff includes JP-4, PD-680 and soap. The soils in the test cell drainage ditch are stained from site runoff.

Site 9. Discharge Area No. 9 (Entomology -- Building 2560)

Discharge Area No. 9 is a gravel basin located adjacent to Building 2560 inside the fenced Civil Engineering Facility. Since 1981, wash water from cleaning pesticide application tanks has been discharged onto this area and allowed to percolate into the soil. There is a small area downhill from the gravel area which has no grass growing. This appears to be the result of site operations. The soils in the area contain hardpan, which helps retard vertical contaminant migration but increases surface runoff.

Site 10. Discharge Area No. 5 (J-58 Test Cell Drainage Ditch)

The J-58 Test Cell is located adjacent to Building 1154 just off Doolittle Drive and is used to test the SR-71 jet engine. The drainage ditch at the test cell receives runoff from the test stand used for engine tests. JP-7, soap, oil, TCE and PD-680 are used here. The soils in the ditch adjacent to the test cell are stained from site runoff.

Site 11. Discharge Area No. 7 (AGE Maintenance Drainage Ditch)

Discharge Area No. 7 is a drainage ditch located behind Building 1225 (AGE maintenance). The ground area adjacent to the paved vehicle parking shows staining likely from POL in site runoff. Some of the stained soils have been removed; although some discoloration is still evident. The hardpan soil in the area is relatively impervious.

Site 12. Discharge Area No. 10 (Entomology -- Building 440)

Discharge Area No. 10 consists of a mixing area adjacent to the southeast corner of Building 440 and a low-lying area 50 feet east of the southeast corner of the building. Building 440 is located on 6th Street, near 9th. This building was used for storing and mixing chemicals used for pest control from 1965 to 1980. The soils around the building are relatively impervious hardpan, thus vertical migration is unlikely.

Site 13. Landfill No. 1

Landfill No. 1 is located on four acres of land in the southwestern sector of the base, west of the sludge dewatering beds at the sewage treatment plant and and about 100 feet north of Hutchinson Creek. The PWTP and Injection Well No. 2 are located immediately adjacent to Landfill No. 1. Refuse was received here in the 1940's, but its source is unknown. The site is no longer used, but subsidence typical of landfill aging has occurred at several locations.

Site 14. Discharge Area No. 8 (Transformer Oil Drainage Area)

The transformer oil drainage area is located in a diked area near 34th and B Streets. From 1977 to 1979, transformers were drained here before being taken into the shop for repair. Soils here contain a layer of hardpan and thus contaminant migration is unlikely; however, some localized vegetation death has occurred. This site is located in a remote part of the base.

Site 15. Landfill No. 3

Landfill No. 3 currently occupies about 40 acres east of Landfill No. 2 on 6th Street. It has been in use since 1981 and waste deposited there is primarily general refuse. Small amounts of chemicals may have been discarded there as well. Operations at this landfill consist of the trench method for waste disposal. The base civil engineering department has a current operating permit for Landfill No. 3.

The soils at this site are hardpan and relatively impervious. Groundwater is a possible contaminant receptor; however, the soils have very low permeability.

Site 16. Explosives Ordnance Disposal Area

The Explosive Ordnance Disposal Area (EOD), located on the northern sector of the base, consists of two bunkers (soil embankments) and a trench approximately 70 feet x 15 feet x 10 feet in size. Unused ordnances from military bases around Sacramento are detonated in the bunkers or in the open field. Large ordnances are detonated in the open field. Diesel fuel and an underlying/overlying layer of wood are used to burn the smaller ordnances. No residual fuel remains after the fire burns itself out. The unburned portion of the ordnances is then disposed of entirely in the trench. During precipitation, the trench fills with water. The standing water provides a hydraulic head which would help move any contaminants in the trench down toward groundwater. Although hardpan may exist at this site, the trench has probably beached any layer which is present.

Site 17. Best Slough

Best Slough flows from east to west on the base before joining Dry Creek. The site, just south of 6th Street and east of Landfill No. 3, was added to the IRP investigation because old empty drums were discovered in a trench 50 feet west of the creek in January 1985. The site consists of five depressions, one of which contains approximately 25 empty drums. The drums are badly rusted and deteriorated. No information is available on what, if anything, the drums contained when they were dumped.

Site 18. Bulk Fuel Storage Facility

The bulk fuel storage areas are located on the corner of 6th and J Streets and contain aboveground fuel tanks. There are dikes around each tank. Civil Engineering personnel have reported minor spillage at the MOGAS rail car loading area. Drainage ditches surround the site. Soils in the area contain a layer of hardpan which will likely reduce infiltration but increase runoff of rainwater.

E. Potential Receptors

Whenever a site is investigated as a potential source of chemical contamination, the risk to the surrounding environment must be considered. Three factors must be investigated to determine whether the site poses a risk: (1) the size and type of chemical source; (2) the pathway by which the chemicals may be transported from the source; and (3) the possible receptors. The HARM scores calculated during the Phase I record search are based on information about each of these factors at each site. Only if there is both a source and a transport pathway from the source does the presence of a receptor need to be investigated fully.

Based on the descriptions of the Beale IRP sites, the only possible transport pathway from potential sources is groundwater migration. Groundwater flows from east to west at Beale AFB (see Figure II-4). Any contamination that enters the groundwater from a site at Beale would also flow to the west. Groundwater wells exist at two locations along the western border of the base.

Base water production wells are located along the northeastern border, and private off-base wells are located along the southwest border (see Figures II-5 and II-6). The base production wells are not immediately downgradient from any of the sites at Beale; however, off-base wells are located so that they could be potential receptors if contaminated groundwater flows off base. Unfortunately, there is insufficient information to determine whether off-base wells are drawing water from the uppermost water-bearing zone (the most likely transport zone). No other potential receptors have been identified.

F. Site-Specific Geology

AeroVironment investigated 18 sites for potential soil or groundwater contamination. Twenty groundwater monitoring wells were installed at 11 of these sites. The locations of these wells are shown on Figure II-7. Using lithologic logs from the wells, AV was able to determine site-specific geology for three general areas of the base. These areas have been created based on the random groupings of wells around the flightline, WWTP and active landfill. Figure II-7 also shows these areas.

1. Area 1 -- Sites 6 (Landfill No. 2) and 15 (Landfill No. 3)

Sites 6 and 15 are located in the southcentral portion of the base. Six groundwater monitoring wells were installed in this area. All of the wells encountered a thick sequence of Laguna Formation (Qtl) from the surface to a depth of 70 to 80 feet. This formation consists of debris derived from erosion of the Sierra Nevada Mountains and deposited as silt, clay, sand, and gravel. Because this is the eastern edge of the formation and quite near the assumed source area of the sediment, the Laguna Formation has more gravel and is generally more coarsely grained in this location than is usual. This gravel is generally found in the upper part of the formation. It is known as the Arroyo Seco gravel in areas south of the base where it is more common.

Immediately underlying the Laguna Formation is a very coarse sand and gravel unit known as the Laguna-Mehrten Transition Zone (Ptm). This

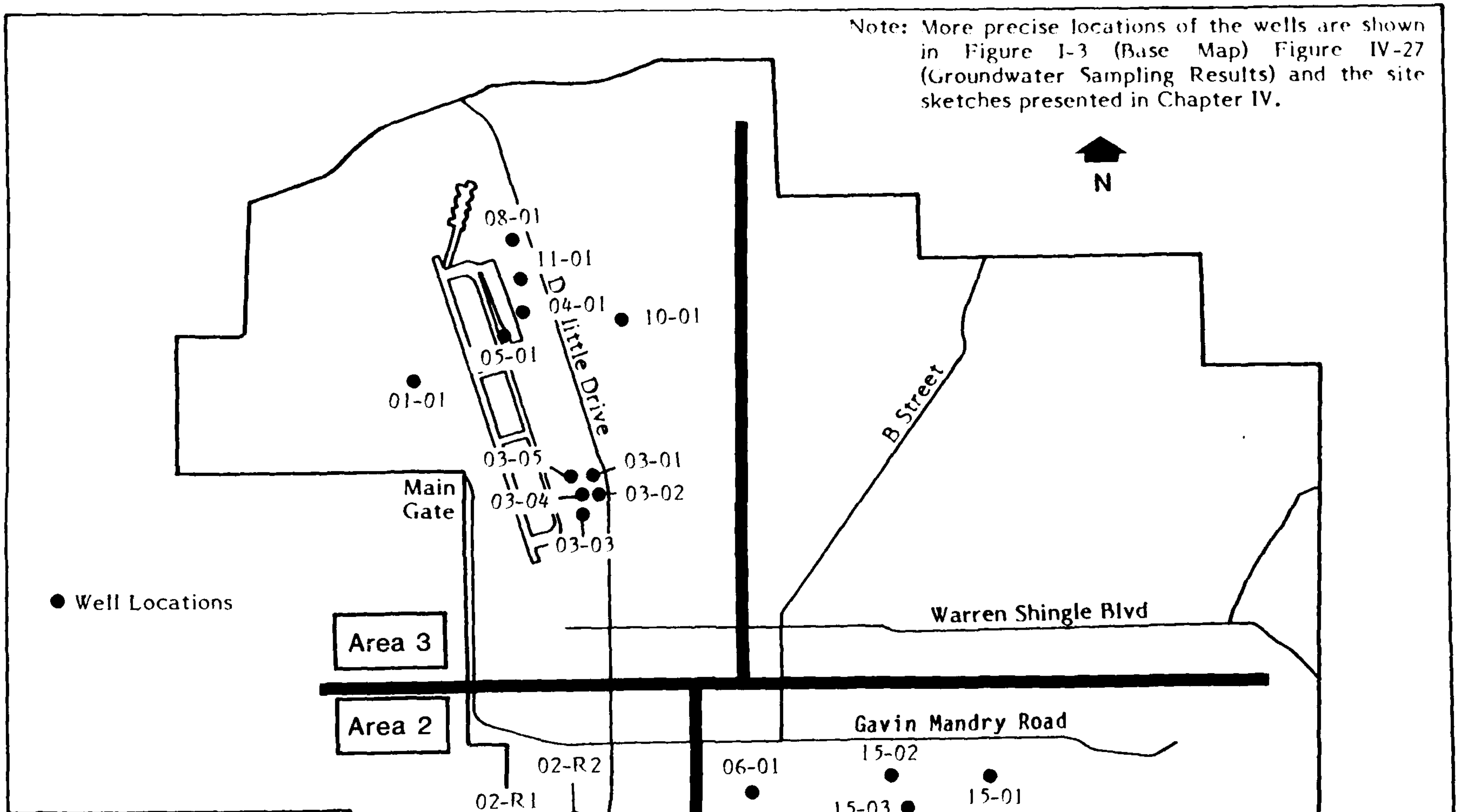


Figure II-7
Groundwater Monitoring
Well Locations
Beale Air Force Base

Reference: Engineering Science, Phase I IRP Report, April 1984

TABLE I-2. (Continued)

Site No.	Site Name	Parameters for Water Samples	Parameters for Soil/Sediment Samples
10	J-58 Test Cell	VOC O&G Petroleum Hydrocarbons Phenols (Total)	VOC O&G Petroleum Hydrocarbons Phenols (Total)
11	AGE Maintenance	VOC O&G Phenols (Total)	VOC O&G Phenols (Total)
12	Entomology Building 440	--	Pesticides/Herbicides
13	Landfill No. 1	VOC O&G Heavy Metals Pesticides/Herbicides Phenols (Total)	VOC O&G Heavy Metals Pesticides/Herbicides Phenols (Total)
14	Transformer Drainage	--	O&G PCBs (608)
15	Landfill No. 3	VOC O&G Heavy Metals Phenols (Total)	--
16	EOD	--	Heavy Metals Explosives Scan
17	Best Slough	VOC O&G Pesticides/Herbicides Phenols (Total)	VOC O&G Pesticides/Herbicides Phenols (Total)
18	Bulk Fuels Storage	--	VOC O&G Petroleum Hydrocarbons Phenols (Total) Lead

Mr. Douglas Taylor, P.E., is a project manager in AV's Environmental Programs Division. He has a Master of Engineering in environmental engineering and six years' experience in hazardous waste management and site assessments. He has managed numerous DoD, EPA, and private party site investigations and sampling programs. As project manager for the Beale study, he was the main interface between AV and USAF OEHL and was responsible for the scheduling of field work (drilling and sampling), for the management of drilling and laboratory subcontractors, and for personnel staffing and technical review.

Mr. Timothy O'Gara is the leader of AV's Earth Sciences Section. He holds a B.A. in earth science and has six years' experience in groundwater monitoring and hazardous waste investigations. Mr. O'Gara has directed drilling, well installation and soil sampling programs at sites throughout California. At Beale, he was responsible for directing the well-drilling program. His duties during this project included coordinating with base personnel, selecting well locations, supervising the drilling crews, and reporting on hydrology.

Mr. Christopher Lovdahl, an environmental chemist at AV, holds a B.S. in environmental science and has six years' experience in environmental compliance, waste site sampling and analytical chemistry. He worked for four years at industrial facilities and analytical laboratories prior to his IRP involvement. At Beale, Mr. Lovdahl was responsible for reviewing well sampling requirements and coordinating with the laboratories. He served as the point of contact between AV and the analytical chemistry laboratory at Acurex, instructing Acurex on selected methods and special handling. He also performed QA/QC reviews on all laboratory data.

Mr. John Miller, a geochemist at AV with an M.Sc. in geochemistry, has eight years' experience in geology and geochemistry in the mining and mineral processing industries. He has worked extensively with soil sampling, laboratory analysis and quality assurance. Mr. Miller served as a field geologist during the well drilling program. He was responsible for logging the samples and designing the wells. He was also active in the QA/QC review of laboratory data.

Ms. Sheryl Thurston, an environmental engineer at AV with a B.S. in environmental engineering, has one year of experience with IRP programs and state RCRA recordkeeping. She served as a field engineer during well drilling at Beale and assisted with driller supervision and sample logging. She was also part of the sampling team and conducted research on base operations and environmental setting.

Complete resumes of the AV personnel mentioned above are included in Appendix I.

AeroVironment also used Mr. John Keating of Gregg and Associates Inc. to assist in well installation and hole logging. Mr. Keating holds a B.S. in geotechnical engineering and has three years of experience with groundwater well drilling and geologic logging.

The Water Development Corporation (Water Development) of Woodland, California, performed the drilling. Water Development has 35 years' experience in drilling water production and monitoring wells at locations throughout California. The company and many of its personnel have specific experience drilling in the Sacramento area and working on IRP programs at other Air Force bases. Water Development provided a D40K Drilteck air rotary drilling rig equipped with a casing hammer and support equipment, with which it drilled, constructed and developed all 20 wells under the direction of AeroVironment field personnel.

Geophysical surveys were conducted at Landfill No. 1 by the Converse Consultants Inc. (Converse) of San Francisco, California. Converse is a highly respected geotechnical consulting firm with over eight years' experience in geophysical investigations. The surveys were completed under the direction of Mr. George Ford (B.S., Geology, Certified Engineering Geologist and Registered Geologist) of Converse. The ground-penetrating radar was performed by Mr. Richard Lee (M.S., Geophysics) of Harding Lawson Associates under the direction of Converse. Mr. Timothy O'Gara of AV coordinated this activity.

Laboratory work was performed by Acurex Corporation (Acurex) of Mountain View, California. Acurex's Energy and Environmental Division joined with AeroVironment as part of the contract team for USAF OEHL. Mr. Gregory Nichol (M.S., Chemistry, eight years' laboratory management experience) served as program manager for the Acurex effort on this task.

Analytical Research Laboratories, Inc. (ARLI) of Monrovia, California, performed the explosive scan testing of EOD samples. Dr. Gerald Delker (Ph.D. Chemistry) coordinated the method research and testing. This lab has since changed its name to Thermo Analytical Inc.

II. ENVIRONMENTAL SETTING

A. Physical Geography

Beale AFB is situated on the eastern flank of the Sacramento Valley, a subdivision of the Great Central Valley. The Great Central Valley is about 60 miles wide and 400 miles long and extends from Bakersfield, California, in the south to Red Bluff, California, in the north (Figure II-1). The Sacramento Valley occupies the northern 150 miles and averages about 30 miles in width.

The Great Central Valley is one of the major structural depressions of the world, containing up to 30,000 feet of Cretaceous and Cenozoic sediments. Currently, the Sacramento Valley consists of a few rivers and many ephemeral streams, all of which have very large floodplains, reflecting infrequent but often heavy precipitation.

1. Topography

During the Pleistocene, the Sacramento Valley consisted of dissected uplands, low alluvial fans and plains, and floodplains. Braided streams (i.e., multiple channel streams) crisscrossed the alluvial plains splitting the lowlands into numerous island-like tracts. The recent (Holocene) climate is drier, so streams carry less sediment and are more often restricted to a single channel with meanders rather than braiding. During this period, topographic features have remained relatively unchanged or have become more pronounced with time.

Beale AFB sits astride the physiographic boundary between the Sierra Nevada foothills and the Sacramento Valley and thus contains a wide range of geomorphology, geology and topography (Figure II-1). Surface drainage is principally from the northeast (Sierra Nevada Mountains) to the southwest (Feather River). At the Feather River, surface flow shifts to a southerly direction and continues on down the Sacramento River to the confluence with the northward-flowing San Joaquin River, from which the combined flow proceeds westward to San Francisco Bay.

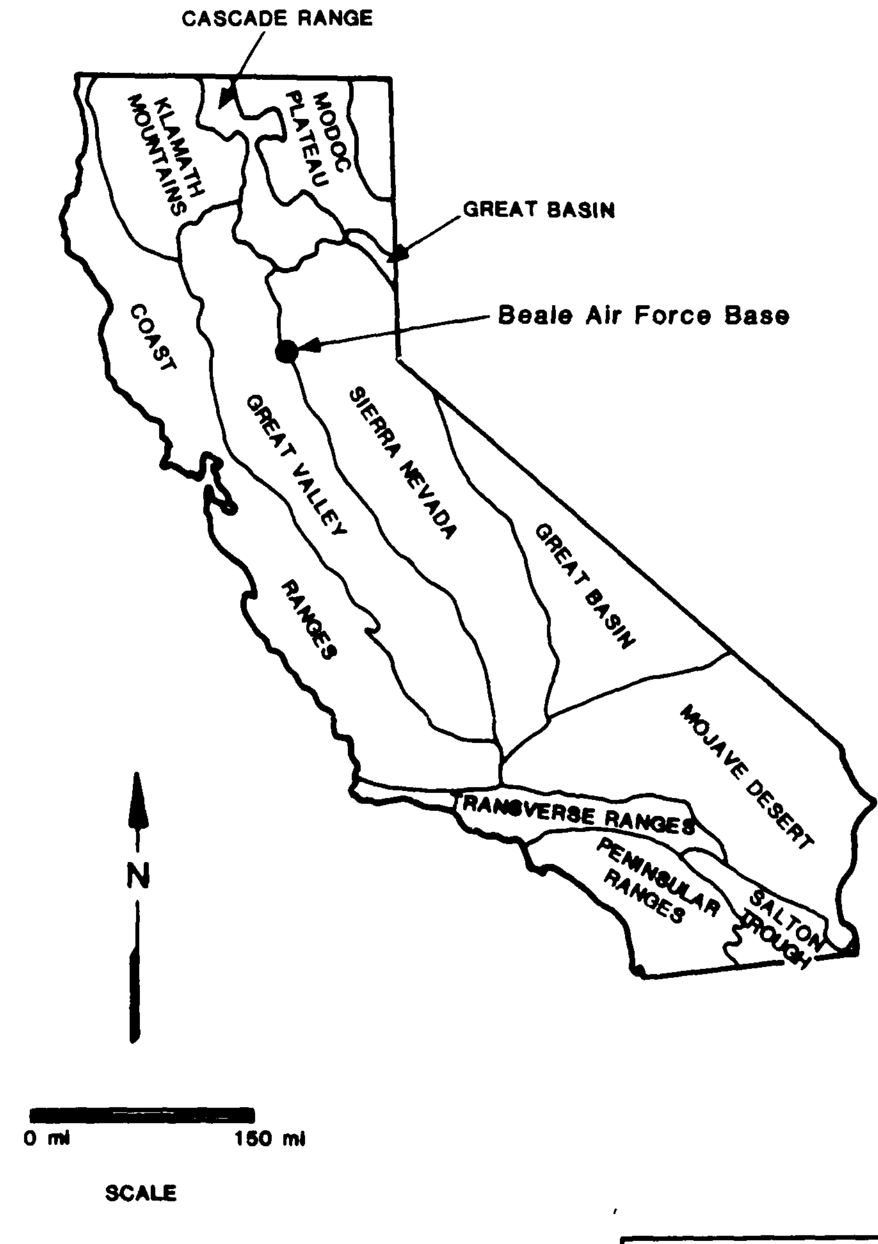


Figure II-1
Physiographic Provinces of California
Beale Air Force Base

AeroVironment Inc.

Source: California Division of Mines and Geology, 1969

The western portion of Beale AFB is typically flat (80 to 125 feet MSL) and consists of a floodplain and small, often ephemeral, meandering or braided streams. Most of AeroVironment's work was performed in this area.

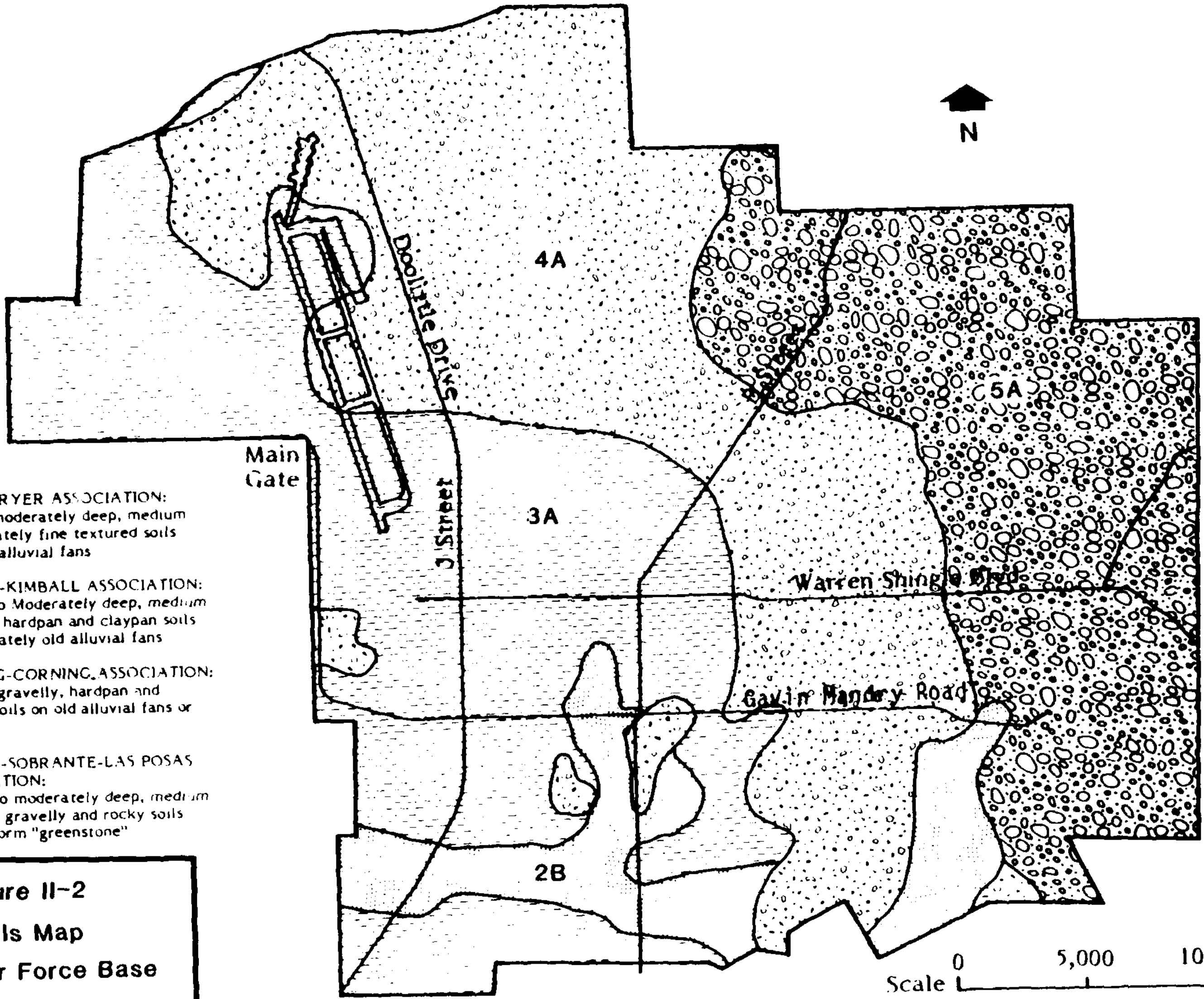
As one moves eastward, streams become better defined and the terrain quickly evolves into dissected uplands with readily visible relief. This terrain (125 to 200 feet MSL) forms the eastern boundary of the Sacramento Valley and comprises about fifty percent of Beale AFB. Most groundwater recharge occurs here and along the Yuba River. The dominant geologic units are tertiary water-worked volcanics and, to a lesser extent, the Quaternary Laguna Formation. AeroVironment performed a small amount of work in this terrain.

2. Soils

Beale AFB contains four different soil associations, which reflect the underlying geologic units that are the soils' parent materials. Figure II-2, taken from a Yuba County soil map by Herbert & Begg (1969), shows the soils at Beale AFB. A more detailed soil map with excellent air photo coverage was prepared by the USDA Soil Conservation Service in 1985. However, the final version of this report is still to be published.

The western third of the base is underlain by the Yokohl-Kimball Association, which formed on moderately old alluvial fans. The soils consist of poorly drained, medium-textured clay and hardpans developed on Victor Formation (Qv). (Note: Qv is a geologic coding that identifies the age of the rock and its formation.)

The midsection of the base contains a strip of soil known as Redding-Corning, which is oriented northwest to southeast. The soil is usually gravel rich with hardpans and claypans. Generally, it overlies the Laguna Formation (Qtl) and Mehrten Formation (Pv). Surface infiltration is moderate, but subsurface infiltration is slow, because the hardpan retards vertical water movement.



Legend

2B WYMAN-RYER ASSOCIATION: Deep to moderately deep, medium to moderately fine textured soils on young alluvial fans

3A YOKOHL-KIMBALL ASSOCIATION: Shallow to Moderately deep, medium textured, hardpan and claypan soils on moderately old alluvial fans

4A REDDING-CORNING ASSOCIATION: Shallow, gravelly, hardpan and claypan soils on old alluvial fans or terraces

5A AUBURN-SOBRANTE-LAS POSAS ASSOCIATION: Shallow to moderately deep, medium textured, gravelly and rocky soils formed form "greenstone"

Figure II-2

Soils Map

Beale Air Force Base

AeroVironment Inc.

Source: Herbert and Begg 1969

Reference: Engineering Science, Phase I IRP Report, April 1984

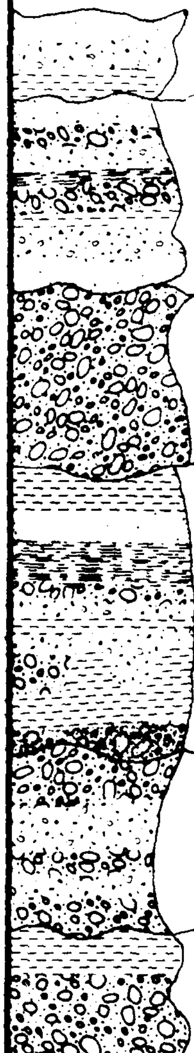
The Auburn-Sobrante-Las Posas Association occupies the eastern portion of the base and is associated with the Sierra Nevada pretertiary basement complex (Pt). It is a shallow, gravelly, and rocky soil formed on decomposing metamorphic, igneous and sedimentary rocks. It is a relatively immature soil, due to the high relief and rapid erosion of the Sierra Nevada.

B. Regional Geology

The stratigraphy and surficial geology discussed below is taken from the work of Page (1974, 1980) and that of Olmsted and Davis (1961). A schematic of the general stratigraphy at Beale Air Force Base is provided in Figure II-3.

Moving from west to east across Beale AFB, one generally encounters progressively older lithologies. In addition, the overall grain size tends to increase and the gravel more and more reflects the Sierra Nevada volcanics and the metamorphic, igneous basement complex. However, one depositional type, quaternary river deposits (Qr), is an exception to this general rule. The Qr of Holocene deposits are the youngest deposits, present-day sediments deposited by drainages such as Hutchinson, Best and Dry Creeks. These deposits are generally only a few feet or tens of feet thick and are mapped by Page as overlying virtually all other formations in areas adjacent to these drainages.

The eastern thirty percent of Beale AFB lies within the Sierra Nevada foothills. The contact between the Sacramento Valley and the Sierra Nevada foothills is geologically defined by pretertiary, metamorphic, igneous and sedimentary rocks belonging to the Sierra Nevada physiographic province. This contact may be crudely approximated by the 200-foot elevation contour. The rocks of this province are considered to be basement (i.e., the lowest and hence oldest rocks exposed in the region). The basement complex slopes to the southwest at two to six degrees, with a maximum of 1,400 feet of posttertiary cover underlying Beale AFB. Little groundwater is found in this terrain and AeroVironment did no work in this area of Beale.



Holocene: (recent) symbol: Qr	Unconsolidated river and stream deposits from current drainage system (0-20 feet). Mostly silt clay and sand; minor gravel.
10' - 20'*	UNDULATORY CONTACT
Victor Formation: (Quaternary) symbol: Qv	Heterogeneous fluviatile clay to gravel sediments. Extremely lenticular deposits from braided streams. Mostly silty sand.
85' - 120'	UNDULATORY CONTACT
Quaternary Gravels: (Quaternary)	Discontinuous gravel layer or lenses (0-50 feet) at base of Victor. Occasionally present at Beale, tends to form hills. Included with Laguna Formation in cross sections.
	UNDULATORY CONTACT
Laguna Formation: (Pleistocene to Pliocene age) symbol: Qtl	Heterogeneous to poorly sorted silt, sand and clay with thin gravel units comprised of silt and clay with fine sand. Approximately 0-120 feet thick.
120' - 140'	UNDULATORY CONTACT
Laguna-Mehrten Transition (Pliocene): symbol: Ptl	Thin to moderate (0-40 feet), locally absent, gravel and/or coarse sand at base of Laguna. Gravel generally angular and dark (mafic) colored. Minor to moderate silt/clay.
130' - 150'	EROSIONAL CONTACT
Mehrten Formation (Miocene Pliocene): symbol: Pv	Volcanic derived angular gravels and sand: dark mafic rock fragments; mudflows. Discontinuous with abundant cross bedding and cut-and-fill structures. Thickness approximately 200 feet. Formation top clay derived from mafic gravels.

* Typical depths found at Beale AFB during Phase II, Stage 1 drilling.

Figure II-3

Typical Stratigraphic Section

Beale Air Force Base

AeroVironment Inc.

Most of AV's drilling was conducted in either the Victor (Qv) or the Laguna (Qtl) Formations. Several drill holes penetrated the Mehrten (Pv), a thick, multicolored clay. Elsewhere, the contact between formations was difficult to locate.

At Beale, the formation of primary interest is the Laguna because most water production wells in the area are completed in or very close to the basal Laguna that hosts the uppermost aquifer. In areas where the Laguna-Mehrten transition zone is present just below the Laguna Formation, this zone is a good water producer for monitoring wells (e.g., Site No. 11). However, its variable thickness (0 to 40 feet) and absence in some areas (e.g., Site No. 3, FPTA) makes it an undesirable aquifer for high-volume wells.

C. Regional Hydrogeology

Groundwater movement has historically been from the Sierra Nevada Foothills eastward to the Feather and Sacramento Rivers. Until the early part of this century, the river system served as a groundwater discharge system. Extensive farming and irrigation rapidly lowered the water table and altered the direction of flow, thus changing the river from a discharge to a recharge system. Additional recharge is permitted by coarse deposits along the Sierra Nevada Foothills. These deposits allow seasonal rainfall/snowmelt to percolate downward.

Regional groundwater contours for the Beale area are shown in Figure II-4. The most obvious feature is the area of intense drawdown southwest of the base boundary caused by irrigation pumping. Between 1945 and 1974, the water table fell about 60 feet and then stabilized in the mid-1970s. However, between 1977 and 1980, the water table declined sharply once more, in response to drought and increased irrigation for rice production (Engle, 1986). Since 1980, the water level has risen markedly, as a result of increased precipitation and lower rice production. Nevertheless, the overall drawdown has been sufficient to alter the direction of local flow in the area of the base well field from west to nearly south. [illegible] of existing base wells is shown in Figure II-5.

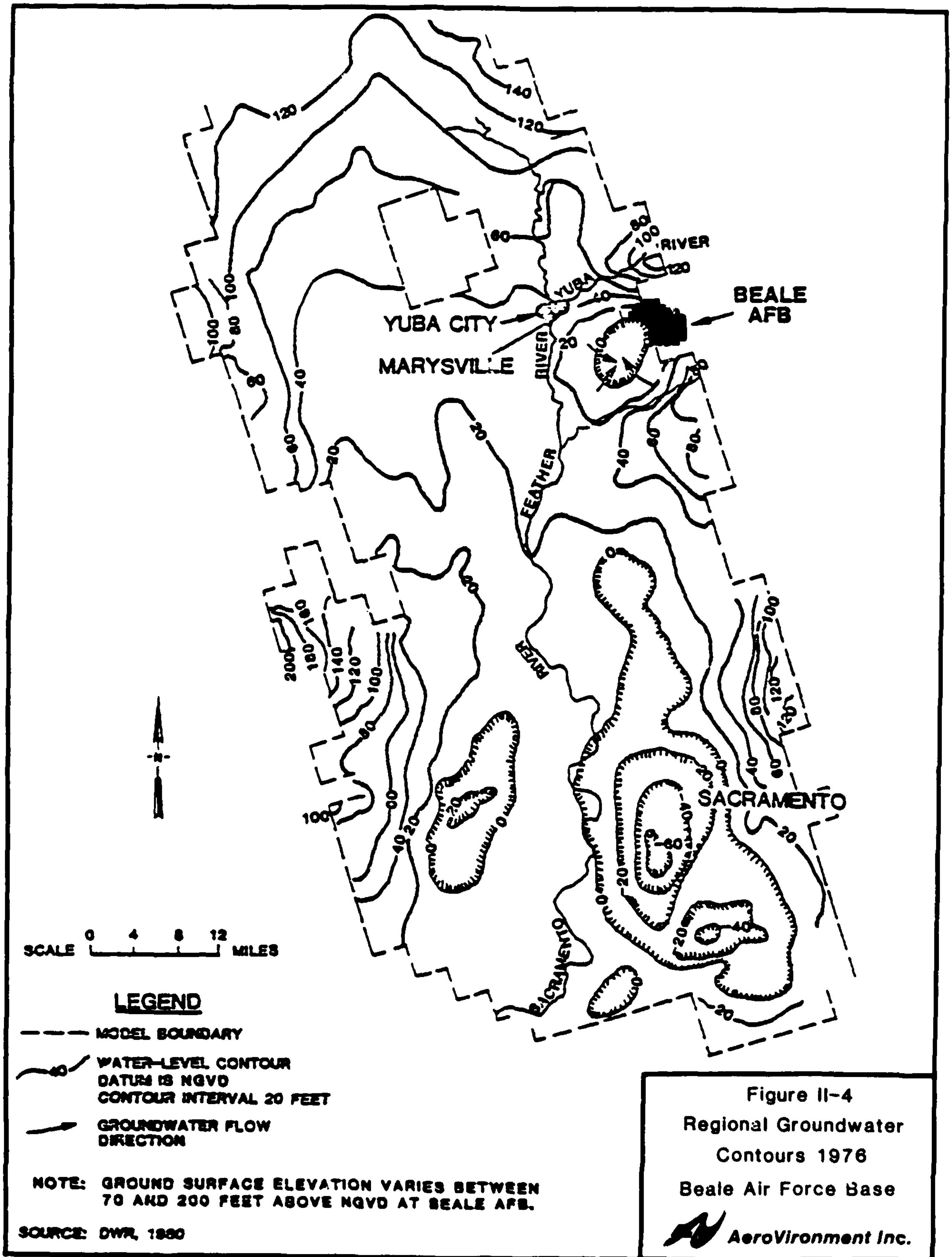


Figure II-4
Regional Groundwater
Contours 1976
Beale Air Force Base

Reference: Engineering Science, Phase I IRP Report, April 1984

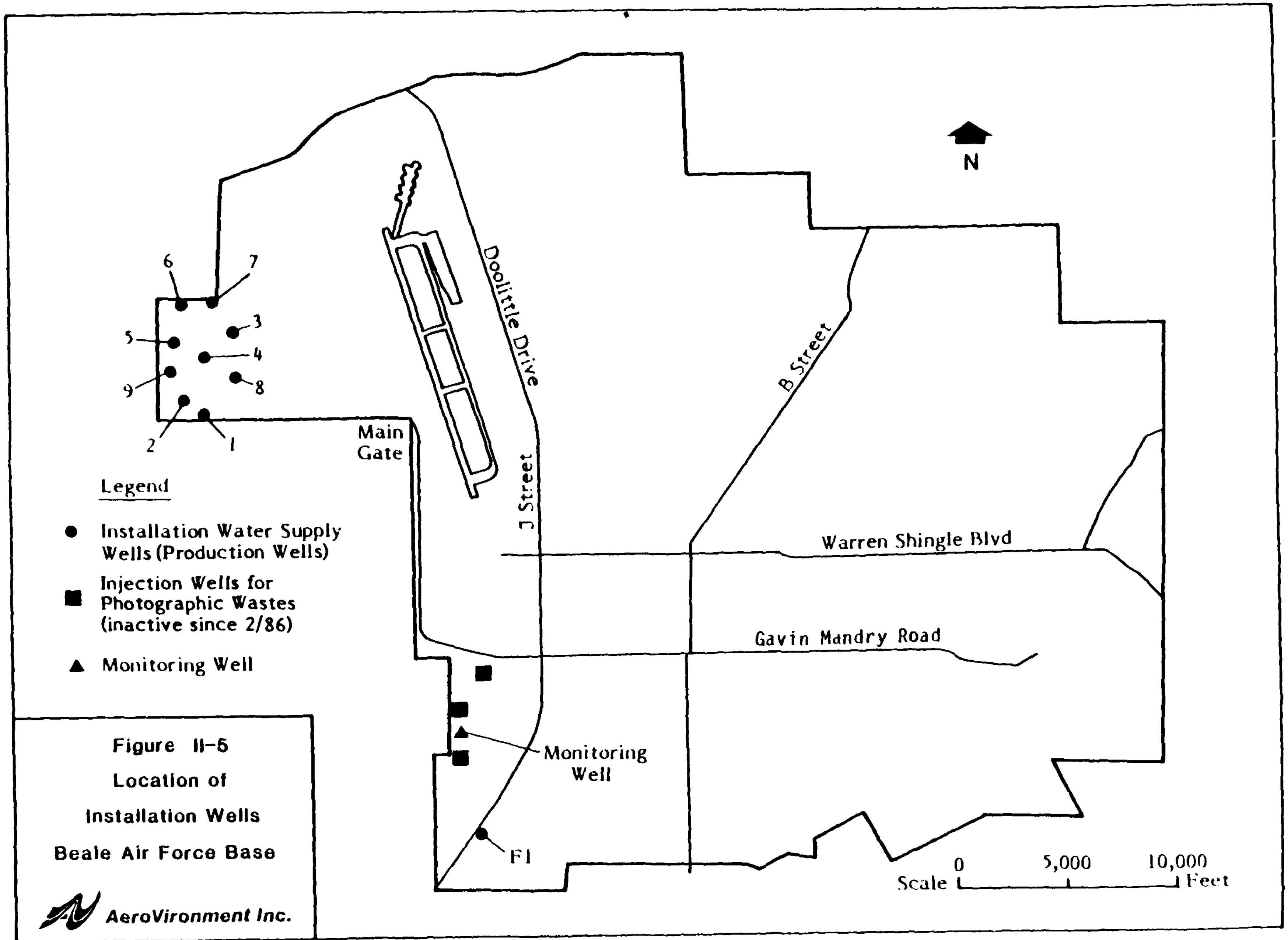


Figure II-5
Location of
Installation Wells
Beale Air Force Base

Reference: Engineering Science, Phase I IRP Report, April 1984

Off-base irrigation and domestic wells on the west and south sides of Beale are shown in Figure II-6. Water levels for these wells, obtained from Mr. D. B. Engel of the Yuba County Agricultural Commission, show an upward trend from 1984 through 1985. The heavy rains of 1985-1986 should insure that the water table will continue to rise throughout 1986.

Studies by Rockwell (1978) and Page (1980) assumed that groundwater tapped by the base wells is basically unconfined except where local clay/silt lenses cap the aquifer to produce semiconfined conditions. Thus the fresh water base occurs at a depth of 300 to 500 feet, coinciding with the base of the undifferentiated sedimentary rocks.

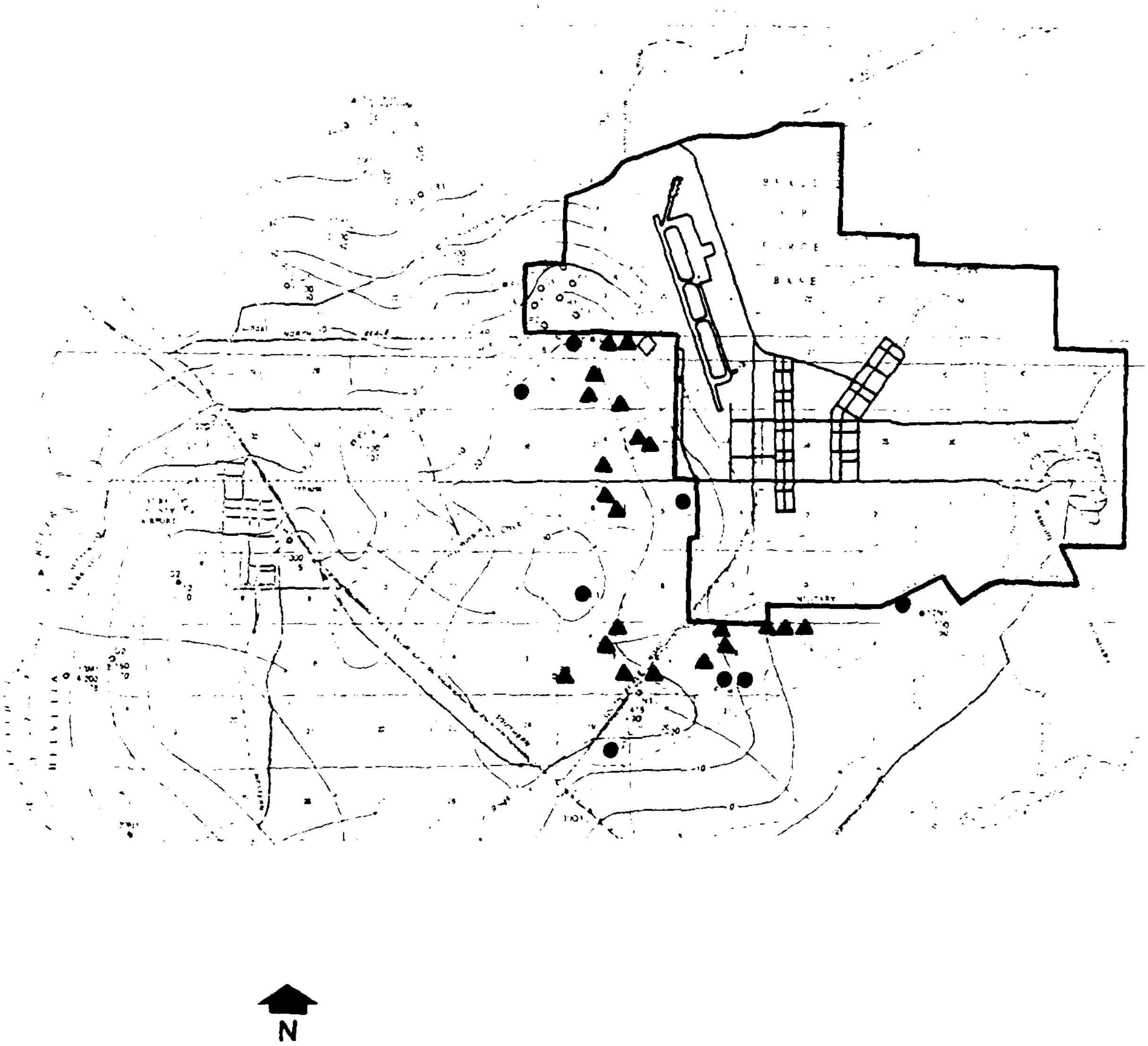
D. Site Descriptions*

Site 1. Discharge Area No. 1 (West Drainage Ditch)

Discharge Area No. 1 (West Drainage Ditch) is a drainage system which drains the flightline and surface runoff from the runway area. The drainage system discharges through a headwall located about 800 feet west of the main runway and into a ditch which is filled with vegetation. Oil absorbent booms have been placed immediately downstream from the headwall. Past surface water quality data indicated oil and grease and trans-1,2 dichloroethene in the water discharged to this ditch. Visual observations indicate that oils have accumulated in the soils of the ditch adjacent to the headwall.

The West Drainage ditch begins less than 1,000 feet from the base boundary. Occasionally, during the wet season (from October through April), water from the ditch flows off base, presenting the potential for environmental contamination outside the base boundary. The site is also less than one mile from off-base groundwater users. Surface soils in the area are medium-textured hardpan and claypan, which have a characteristically low permeability; thus they would restrict percolation of water and any contaminants.

*The information presented in this section was taken from the Engineering Science Phase I IRP Report and on-site observations interviews during Stage 1.



Scale 0 2 Miles

Legend

● Domestic Wells
▲ Irrigation Wells
◇ Unknown Use

Source: Rockwell, 1978, Page, 1980, Yuba County Agricultural Commission

Figure II-6

Location of Area Wells

Beale Air Force Base

AeroVironment Inc.

Reference: Engineering Science, Phase I IRP Report, April 1984

Site 2. Photo Wastewater Treatment Plant and Injection Well No. 2

The Photo Wastewater Treatment Plant (PWTP) has been used since 1966 to treat photo wastes. It is located on the southwest portion of the base and receives wastes from the photo laboratory (Building 2145) 2.5 miles to the northwest. Average waste flow is 20,000 gpd. Treatment and processes include equalization, chemical flocculation, settling, and filtration. Three injection wells were used for PWTP effluent disposal until injection was discontinued in April 1986. Four groundwater monitoring wells were installed around the Photo Waste Sludge Pond in 1985 by Radian Corporation. These wells are used to monitor for evidence of contamination from the earthen-lined ponds.

The concern at Site 2 results from the unlined pond and the occasional discharging of treated PWTP effluent onto the ground near the well heads. This site (plant and injection wells) is approximately 500 feet from the base boundary and less than 500 feet from Hutchinson Creek. Soils are medium-textured hardpan that have low permeability and, therefore, retard vertical movement.

Site 3. Fire Protection Training Areas Nos. 1 and 2

Fire-fighting exercises were conducted at Fire Protection Training Area (FPTA) No. 1 from 1958 to 1971 and have been conducted at FPTA No. 2 since 1972. The two sites have been combined for this investigation because of their proximity. FPTA No. 1 is located in the half-acre adjacent to the intersection of J and 27th Streets. It contained a shallow, two-foot-deep, unlined basin. There is no visual evidence of the old FPTA No. 1. FPTA No. 2 is located about 200 feet west of FPTA No. 1. It consists of a shallow basin 150 feet in diameter surrounded by a 12-inch berm. Inside the basin is a mock aircraft used for fire training exercises. About 100 feet south of the mock aircraft is an unlined 100-foot-square basin designed to hold the liquid which runs off of FPTA No. 2. Fire training exercises involve simulated full fires in and around the mock aircraft and is intended for firefighter training. Residual fuel and water is left in the unlined basin.

The site is located within 1 mile of the base boundary. Surface soils contain a layer of hardpan, which has very low permeability and retards vertical contamination.

Site 4. Discharge Area No. 2 (Battery Shop Dry Well)

A sink drain in Building 1088, used to dispose of rinsate after acid is drained into containers from lead acid batteries, was connected into a dry well. The "dry well" was four feet in diameter and approximately 20 feet deep and filled with cobbles. The neutralized acid could have high concentrations of lead. Use of the dry well was discontinued in 1983.

Site 5. Discharge Area No. 3 (SR-71 Shelter)

The SR-71 aircraft is so constructed that it will leak JP-7 while on the ground. It has been estimated that the planes lose about 300 gallons of fuel per week. A major portion of the fuel is lost in the vicinity of the SR-71 shelters and on Taxiway No. 10 east of the shelters. Some of the fuel runs off the taxiway into an oil-water separator. Another portion of the fuel runs off into the adjacent storm sewer which is upstream of DA-1. The soils adjacent to the taxiway area are discolored in areas indicating potential contamination.

Site 6. Landfill No. 2

Landfill No. 2 occupies 56 acres in the southern sector of the base. It was used primarily for refuse disposal from the early 1950s until 1980. Between 1967 and 1978, about 380 cubic yards of sludge from the Photo Wastewater Treatment Plant were disposed of here. Small amounts of chemicals and petroleum were also discarded here. Landfill No. 2 is currently used to dispose of dirt, wood and other construction and grounds maintenance debris.

Site 7. Discharge Area No. 4 (Army Biological Production Site)

During the period 1962 to 1969, the U.S. Army produced wheat stem rust at the biological test site located adjacent to Building 1154, in the southwest corner of the base. In 1969, the production stocks remaining at Beale were destroyed and the material was rendered inactive by carboxide treatment and incineration. The residual ash was assayed and plowed into the soil at the site to a depth of six inches. The entire destruction process was accomplished successfully, in complete cooperation with federal and state agricultural authorities. The only chemicals used at the site were Freon, carbon dioxide, ethylene oxide and possibly TCE.

The site is currently used as the Base Gun Club. Game birds are housed in large pens throughout the site.

Site 8. Discharge Area No. 6 (J-57 Test Cell Drainage Ditch)

The J-57 Test Cell is located adjacent to Building 1247 at the north end of the flightline. The drainage ditch at the test cell receives runoff from the test stand used to test aircraft engines. The runoff includes JP-4, PD-680 and soap. The soils in the test cell drainage ditch are stained from site runoff.

Site 9. Discharge Area No. 9 (Entomology -- Building 2560)

Discharge Area No. 9 is a gravel basin located adjacent to Building 2560 inside the fenced Civil Engineering Facility. Since 1981, wash water from cleaning pesticide application tanks has been discharged onto this area and allowed to percolate into the soil. There is a small area downhill from the gravel area which has no grass growing. This appears to be the result of site operations. The soils in the area contain hardpan, which helps retard vertical contaminant migration but increases surface runoff.

Site 10. Discharge Area No. 5 (J-58 Test Cell Drainage Ditch)

The J-58 Test Cell is located adjacent to Building 1154 just off Doolittle Drive and is used to test the SR-71 jet engine. The drainage ditch at the test cell receives runoff from the test stand used for engine tests. JP-7, soap, oil, TCE and PD-680 are used here. The soils in the ditch adjacent to the test cell are stained from site runoff.

Site 11. Discharge Area No. 7 (AGE Maintenance Drainage Ditch)

Discharge Area No. 7 is a drainage ditch located behind Building 1225 (AGE maintenance). The ground area adjacent to the paved vehicle parking shows staining likely from POL in site runoff. Some of the stained soils have been removed; although some discoloration is still evident. The hardpan soil in the area is relatively impervious.

Site 12. Discharge Area No. 10 (Entomology -- Building 440)

Discharge Area No. 10 consists of a mixing area adjacent to the southeast corner of Building 440 and a low-lying area 50 feet east of the southeast corner of the building. Building 440 is located on 6th Street, near 9th. This building was used for storing and mixing chemicals used for pest control from 1965 to 1980. The soils around the building are relatively impervious hardpan, thus vertical migration is unlikely.

Site 13. Landfill No. 1

Landfill No. 1 is located on four acres of land in the southwestern sector of the base, west of the sludge dewatering beds at the sewage treatment plant and and about 100 feet north of Hutchinson Creek. The PWTP and Injection Well No. 2 are located immediately adjacent to Landfill No. 1. Refuse was received here in the 1940's, but its source is unknown. The site is no longer used, but subsidence typical of landfill aging has occurred at several locations.

Site 14. Discharge Area No. 8 (Transformer Oil Drainage Area)

The transformer oil drainage area is located in a diked area near 34th and B Streets. From 1977 to 1979, transformers were drained here before being taken into the shop for repair. Soils here contain a layer of hardpan and thus contaminant migration is unlikely; however, some localized vegetation death has occurred. This site is located in a remote part of the base.

Site 15. Landfill No. 3

Landfill No. 3 currently occupies about 40 acres east of Landfill No. 2 on 6th Street. It has been in use since 1981 and waste deposited there is primarily general refuse. Small amounts of chemicals may have been discarded there as well. Operations at this landfill consist of the trench method for waste disposal. The base civil engineering department has a current operating permit for Landfill No. 3.

The soils at this site are hardpan and relatively impervious. Groundwater is a possible contaminant receptor; however, the soils have very low permeability.

Site 16. Explosives Ordnance Disposal Area

The Explosive Ordnance Disposal Area (EOD), located on the northern sector of the base, consists of two bunkers (soil embankments) and a trench approximately 70 feet x 15 feet x 10 feet in size. Unused ordnances from military bases around Sacramento are detonated in the bunkers or in the open field. Large ordnances are detonated in the open field. Diesel fuel and an underlying/overlying layer of wood are used to burn the smaller ordnances. No residual fuel remains after the fire burns itself out. The unburned portion of the ordnances is then disposed of entirely in the trench. During precipitation, the trench fills with water. The standing water provides a hydraulic head which would help move any contaminants in the trench down toward groundwater. Although hardpan may exist at this site, the trench has probably beached any layer which is present.

Site 17. Best Slough

Best Slough flows from east to west on the base before joining Dry Creek. The site, just south of 6th Street and east of Landfill No. 3, was added to the IRP investigation because old empty drums were discovered in a trench 50 feet west of the creek in January 1985. The site consists of five depressions, one of which contains approximately 25 empty drums. The drums are badly rusted and deteriorated. No information is available on what, if anything, the drums contained when they were dumped.

Site 18. Bulk Fuel Storage Facility

The bulk fuel storage areas are located on the corner of 6th and J Streets and contain aboveground fuel tanks. There are dikes around each tank. Civil Engineering personnel have reported minor spillage at the MOGAS rail car loading area. Drainage ditches surround the site. Soils in the area contain a layer of hardpan which will likely reduce infiltration but increase runoff of rainwater.

E. Potential Receptors

Whenever a site is investigated as a potential source of chemical contamination, the risk to the surrounding environment must be considered. Three factors must be investigated to determine whether the site poses a risk: (1) the size and type of chemical source; (2) the pathway by which the chemicals may be transported from the source; and (3) the possible receptors. The HARM scores calculated during the Phase I record search are based on information about each of these factors at each site. Only if there is both a source and a transport pathway from the source does the presence of a receptor need to be investigated fully.

Based on the descriptions of the Beale IRP sites, the only possible transport pathway from potential sources is groundwater migration. Groundwater flows from east to west at Beale AFB (see Figure II-4). Any contamination that enters the groundwater from a site at Beale would also flow to the west. Groundwater wells exist at two locations along the western border of the base.

Base water production wells are located along the northeastern border, and private off-base wells are located along the southwest border (see Figures II-5 and II-6). The base production wells are not immediately downgradient from any of the sites at Beale; however, off-base wells are located so that they could be potential receptors if contaminated groundwater flows off base. Unfortunately, there is insufficient information to determine whether off-base wells are drawing water from the uppermost water-bearing zone (the most likely transport zone). No other potential receptors have been identified.

F. Site-Specific Geology

AeroVironment investigated 18 sites for potential soil or groundwater contamination. Twenty groundwater monitoring wells were installed at 11 of these sites. The locations of these wells are shown on Figure II-7. Using lithologic logs from the wells, AV was able to determine site-specific geology for three general areas of the base. These areas have been created based on the random groupings of wells around the flightline, WWTP and active landfill. Figure II-7 also shows these areas.

1. Area 1 -- Sites 6 (Landfill No. 2) and 15 (Landfill No. 3)

Sites 6 and 15 are located in the southcentral portion of the base. Six groundwater monitoring wells were installed in this area. All of the wells encountered a thick sequence of Laguna Formation (Qtl) from the surface to a depth of 70 to 80 feet. This formation consists of debris derived from erosion of the Sierra Nevada Mountains and deposited as silt, clay, sand, and gravel. Because this is the eastern edge of the formation and quite near the assumed source area of the sediment, the Laguna Formation has more gravel and is generally more coarsely grained in this location than is usual. This gravel is generally found in the upper part of the formation. It is known as the Arroyo Seco gravel in areas south of the base where it is more common.

Immediately underlying the Laguna Formation is a very coarse sand and gravel unit known as the Laguna-Mehrten Transition Zone (Ptm). This

Note: More precise locations of the wells are shown in Figure I-3 (Base Map) Figure IV-27 (Groundwater Sampling Results) and the site sketches presented in Chapter IV.

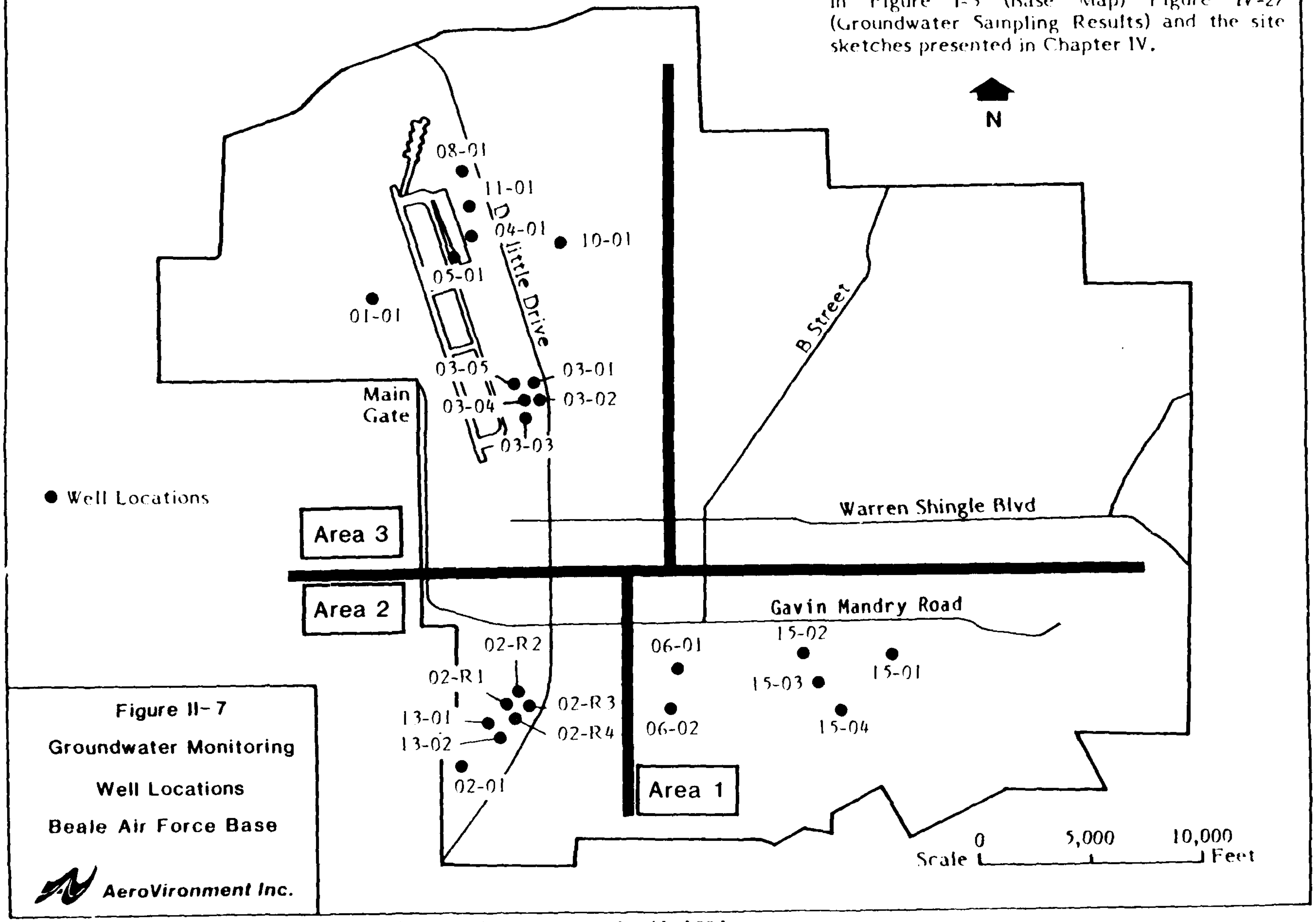


Figure II-7

Groundwater Monitoring

Well Locations

Beale Air Force Base

AeroVironment Inc.

Reference: Engineering Science, Phase I IRP Report, April 1984

zone has been mapped in various studies as either basal Laguna or uppermost Mehrten Formation. It was found in all of the wells in the south half of the base, but was missing in some areas near the flightline to the north. The gravels of the transition zone were encountered in the bottom 25 to 35 feet of all borings in Area 1. None of the borings penetrated through the transition zone to the volcanic clays of the Mehrten Formation, which is directly beneath this zone in the borings to the west.

2. Area 2 -- Sites 2 (Photo Injection Well 2) and 13 (Landfill No. 1)

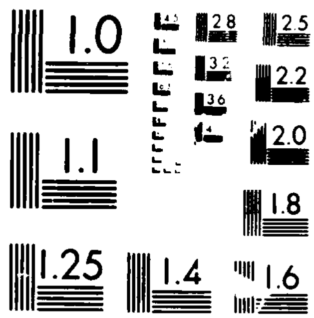
Three wells were drilled near the Photo Waste Injection Well System and downgradient from Landfill No. 1. These wells all encountered very fine over-bank stream deposits from the surface down to 15 feet. The stream deposits directly overlie a 40- to 70-feet-thick section of the Laguna Formation. The Laguna is more finely grained in this area, which is 1-1/2 miles down dip from Area 1, and looks more like the typical Laguna Formation described in the literature. The Laguna-Mehrten Transition Zone is found directly beneath the Laguna Formation. It is 25-35 feet thick in this area.

All three of the well borings encountered the top of the Mehrten Formation (Pv) below the transition zone. The Mehrten is easily identified by the change from terrigenous clastic to pyroclastic sediments, in this case, a dark volcanic clay. Phase II wells extend 5 to 10 feet into the Mehrten Formation.

3. Area 3 -- Flightline Sites

Area 3 has seven sites and eleven wells. The sites [illegible] Figure I-3. The uppermost formation in this area is the Victor Form[illegible] which consists of silt, sand and buried channels of gravel that [illegible] streams draining the Sierra Nevada Mountains during the [illegible] directly overlies the Laguna Formation, which is [illegible] Victor Formation is up to 120 feet thick in the [illegible] wedges down to 10 feet thick in the south[illegible]

AD-A183 968 INSTALLATION RESTORATION PROGRAM PHASE 2 2/4
CONFIRMATION/QUANIFICATION STAGE..(U) AEROVIRONMENT INC
MONROVIA CA R BAUER 29 MAY 87 AV-FR-86/517R2-VOL-1
UNCLASSIFIED F33615-83-D-4000 F/G 24/4 NL



MICROCOPY RESOLUTION TEST CHART

The Victor probably pinches out near the southern edge of the runway; it thickens gradually to the west.

The Laguna Formation is found directly below the Victor. In the northern end, near the J-57 Test Cell, it is only 25 feet thick and 100 feet below the ground surface, beneath a thick sequence of Victor Formation. In the south, where the Victor thins, the Laguna begins at 10 feet below the ground surface and extends down to 120 feet. The Laguna-Mehrten Transition Zone is found only in the center of this area. It is missing at the Fire Protection Training Area in the south end of Area 3, as well as at the J-57 Test Cell near the north end of the runway. Where it is found, this zone is no more than 15 feet thick.

All but two of the eleven wells drilled in this area encountered the Mehrten Formation. The two that did not stopped in the transition zone. One of the wells in the Fire Protection Training Area penetrated 40 feet of volcanic clay from 120 to 160 feet. Generally, the Mehrten Formation was first encountered at 120 to 140 feet below ground surface.

G. Historic Groundwater Problems

In this area, the main groundwater problem caused by man is the lowering of the water table and the changing of regional flow patterns by overpumping in areas southwest of the base. There are no known historical problems of man-made contamination of local groundwater supplies.

H. Location of Wells

At Beale Air Force Base, water is pumped from nine water supply wells (base production wells). Their locations were indicated in Figure II-5. Table II-1 gives the construction details of these base wells. Pumping from the groundwater reservoir at Beale ranged from 1,370 to 4,240 acre-feet between 1960 and 1975, with the major pumping occurring between May and September. The water is generally of good quality and appears to be of sodium-calcium chloride and sodium-calcium bicarbonate types.

TABLE II-1. Construction details for installation water supply wells.

Well		Depth (feet)	Perforation Intervals (feet)	Casing Diameter (inches)
Installation Number	USGS Number			
1	15N/4E-24R1	296	175-296	12/16
2	15N/4E-24R2	326	145-160 234-310	16
3	15N/5E-19F1	264	152-251	
4	15N/4E-24H1	405	158-288	16
5	15N/4E-24G1	299	112-154 210-224 238-280	16
6	15N/4E-24B1	313	130-156 192-213 235-241 252-264 289-299	16
7	15N/4E-24A1	300	140-270	16(?)
8	15N/5E-19L1	405	129-206 280-293	?
9	15N/4E-24K1	370	186-330	?

Source: Engineering Science, Phase I, IRP Report, April, 1984

In February 1978, all the base wells except Well 3 were sampled for the presence of TCE. None of the samples showed TCE concentrations greater than the detection limit of 1.5 ppb. Wells 1, 2, 3 and 8 were tested again in August 1983 and all samples were below the detection limit of 0.1 ppb.

In 1966, a monitoring well was installed in the vicinity of the three photo waste injection wells. These injection wells are more than 1,200 feet deep and inject wastes into saline-water-bearing strata. The monitoring well construction details are included in Table II-2. Samples are collected monthly and analyzed for cyanide, silver and bromide. Any results over the detection limits for these parameters have been attributed to lab errors. The monitoring well near the injection wells is screened in a zone near the bottom of the water table aquifer and is not useful for detecting downward movement of potential contaminants. Four additional monitoring wells were installed around the Photo Waste Sludge Pond in 1985. Sampling from these wells showed concentrations of phenol above state and federal standards (Radian, 1985).

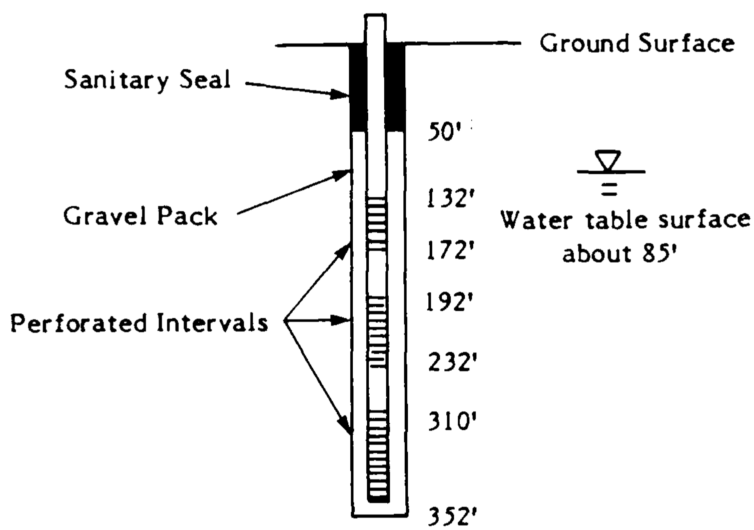
Many irrigation and some domestic wells are located downgradient from base boundaries. Information about their construction is limited, but their depths probably exceed 100 feet. In 1976, groundwater quality data were collected for selected wells outside the base boundaries. Figure II-6 shows their locations. The analyses showed that these wells exceeded secondary standards for manganese, nitrates and chloride (USGS, 1980). Secondary standards address the aesthetic quality of drinking water, while primary standards are required standards for drinking water supplies.

I. Meteorology

Table II-3 summarizes recent historical averages for temperature and precipitation. The annual evaporation rate (66.5 inches), coupled with the average yearly rainfall (21.4 inches), yields a net precipitation of minus 45.1 inches. This implies that precipitation has little chance to percolate to the regional groundwater table, suggesting in turn a low potential for leachate generation via

TABLE II-2. Photo waste injection monitoring well specifications.

Total Depth (ft)	352
Sanitary Seal (ft)	0-50
Gravel Pack (ft)	50-352
Perforated Intervals (ft)	132-172
	192-232
	310-352
Casing Diameter(in)	8-5/8



Reference: Engineering Science, Phase I IRP Report, April 1984

TABLE II-3. Precipitation and Temperature Summary.

	Precipitation (inches, 1960-1985)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly
Mean	4.1	3.4	3.1	1.8	0.4	0.2	0.1	0.1	0.4	1.5	4.1	3.2	23.1
Minimum	0.4	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	8.3
Maximum	9.5	10.3	6.9	5.9	1.2	1.4	1.9	1.0	2.3	11.0	8.9	7.8	38.5
24 Hr. Max.	2.9	3.5	2.5	2.2	1.1	0.7	1.8	0.4	2.0	5.5	3.2	2.1	--
	Temperature (^{O}F, 1959-1981)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly
Mean	46	51	54	58	67	74	79	77	74	64	53	45	62
Minimum	22	27	26	33	38	44	52	49	42	35	29	20	20
Maximum	77	79	86	90	102	111	114	111	109	101	85	75	114

Reference: Engineering Science, Phase I IRP Report, April 1984

precipitation, especially considering the low permeability of soils on and near Beale AFB (EPA/530/SW-168 and USDA SCS, 1985). A monthly water balance calculation was performed, using data from nearby Nicholas, CA. This calculation verified that there is no percolation during most years.

Although a 5.5-inch, 24-hour rainfall occurred in October 1962, the U.S. Air Force Technical Applications Center estimated the more typical 24-hour rainfall for Beale AFB to be 3.5 inches or less. This value is an indication of runoff and erosion and is considered to suggest moderate erosion and runoff potential. As shown in Table II-3, 95 percent of the rainfall occurs during a seven-month "wet season" from October through April. During this period, rainstorms of moderate intensities occur frequently. Significant runoff occurs due to impermeable soils and hardpans. However, the relatively low relief results in low to moderate erosion potential for most of the base.

J. Summary of Environmental Setting

A review of information regarding the environmental setting at Beale AFB reveals the following:

- The soils on the base consist of medium textured clay and hardpans that are relatively impervious to the vertical movement of water and thus of contaminants. A net precipitation of -45 inches further ensures a low potential for downward flow.

- The flat terrain on Beale AFB creates low potential for contaminant transport through erosion.

- The geology at Beale varies. In and near the flightline (Area 3), the Victor Formation is near the surface, below surface soils. It sometimes contains hardpan, which can retard downward contaminant migration. Below the Victor lies the Laguna Formation. It consists of silt, clay, sand and gravel, which provide a conduit for vertical contamination flow if the hardpan above is breached. The Laguna-Mehrten Transition Zone is no more than 15 feet thick below the Laguna and does not exist in some areas. Its consistency is a coarse sand and gravel. In areas

where it does exist, this zone is a good water producer for monitoring wells. Otherwise, the Laguna usually hosts the uppermost aquifer. Below this transition zone is found the Mehrten Formation, which is characteristically a dark, volcanic clay.

In areas outside the flightline (Areas 1 and 2), no Victor Formation exists, so the Laguna Formation lies below surface soils. In these areas, if the soil does not contain hardpan or the hardpan layer is breached, contaminants have an easy flowpath to the water table.

Water for the base is currently pumped from seven water supply wells and water quality is generally good. Two other base production wells have been closed because of mechanical problems.

III. FIELD PROGRAM

A. Development

1. Preliminary Activities

AeroVironment (AV) began work at Beale AFB in May 1985 with an orientation visit on May 8, 1985. AV visited each of the proposed sites and was briefed on the history and previous IRP work at the site. AV reached agreement on the locations of planned groundwater monitoring wells with Ms. Marge Rouch of the California Department of Health Services and Mr. Ken Landeau of the Regional Water Quality Control Board who were also present during the site visit.

2. Subcontractor Selection

a. Drilling

The statement of work specified 20 groundwater monitoring wells to be drilled using the air rotary method and a casing hammer. Up to 39 shallow soil borings using hollow stem augers were also specified. After the statement of work had been finalized and before the task order was assigned, AV investigated the availability of air rotary drilling equipment at potential subcontractors. Only three drilling companies were found to have this relatively specialized equipment.

AV prepared a Request for Bid (RFB) package for the well drilling and hollow stem augering work. It asked for cost quotations of hourly rates for drilling, well construction and development. The bidders were also to quote material costs for well construction. AV received bids from Beylik, P.C. Exploration, and Water Development on August 19, 1985. These were evaluated for cost and demonstration of ability to perform the work. AV judged all three firms to have adequate experience in projects of similar size and scope. Water Development was selected based on cost, proximity to the site and experience working on IRP projects at other bases in California. Although this bidding was

originally conducted for AV's other IRP program in Northern California, after negotiation, both companies agreed that the offered prices would remain the same for similar work at Beale AFB.

b. Geophysical Studies.

The statement of work included geophysical studies (ground-penetrating radar and magnetometer) at Landfill No. 1 at Beale AFB. Between May and September, AV received technical and cost proposals for two firms to complete this work, the Earth Technology Corporation (Earth Technology) of Long Beach, California. and Converse Consultants (Converse) of San Francisco, California. AV considered both to be technically equivalent. Converse was selected based on proximity to the site and AV's previous satisfactory experience in working with Converse.

3. Technical Operations Plan

In compliance with the project statement of work, AV prepared a Technical Operations Plan that detailed the sampling, analytical, and documentation procedures to be used on the project (see Appendix K). This plan was submitted to USAF OEHL for review in October 1985, prior to the start of field work. After receiving approval of the plan, AV began to finalize details of the field program.

AV's analytical chemistry subcontractor, Acurex Corporation, was extensively involved in preparing the Technical Operations Plan and was aware of all requirements that pertained to it. Further discussion of the AV-Acurex interface is given in Section III.B.5. Drilling and geophysical subcontractors worked closely with AV field personnel to ensure that they were in compliance with the applicable sections of the plan.

4. Safety Plan

AV and Air Force policies require that an appropriate health and safety plan be prepared before field activities can begin. Safety concerns related to this field work focused on the hazardous nature of some chemicals suspected of being present at the site, as well as the "unknowns" relative to exact location, concentration and volume of possible contaminants. In addition, the potential for mechanical injury from drilling machinery was of concern.

The site safety plan used by AV's field team is included as Appendix K. It required that all field personnel wear standard work outfits (steel-toed boots, hardhats, etc.). It also required that the air at all sites be monitored for organic vapors, oxygen deficiency and explosive gases.

Work at all the sites at Beale AFB consisted of drilling and sample collecting. These activities bring to the surface potentially contaminated soils and water that were previously isolated. The potential for skin exposure or inhalation was significant. The drilling program was specifically designed to eliminate drilling through waste material or spill sites. AV placed all wells at upgradient or downgradient locations. All work areas were relatively flat, out of doors, with good air circulation. When handling apparently uncontaminated samples, workers wore new, disposable latex gloves at each sampling location to keep skin clean and to avoid cross-contamination from sample handling. When collecting samples thought to be contaminated, workers wore coveralls and 14-inch neoprene gloves over the latex gloves.

The ambient air was monitored to alert the field team if hazardous concentrations in the breathing zone rose above acceptable levels. The following action levels were set up for organic vapor meter readings:

0-5 ppm (above background):	no respiratory protection needed
5-50 ppm:	air purifying respirator with organic chemical cartridge
50 - 500 ppm:	self-contained breathing apparatus
500 ppm and above:	no work

Other criteria were set for oxygen deficiency and explosive gases.

Air Force personnel at Beale AFB were aware of all activities each day. Emergency services (fire, police and hospital) were available on-base.

B. Implementation of Field Program

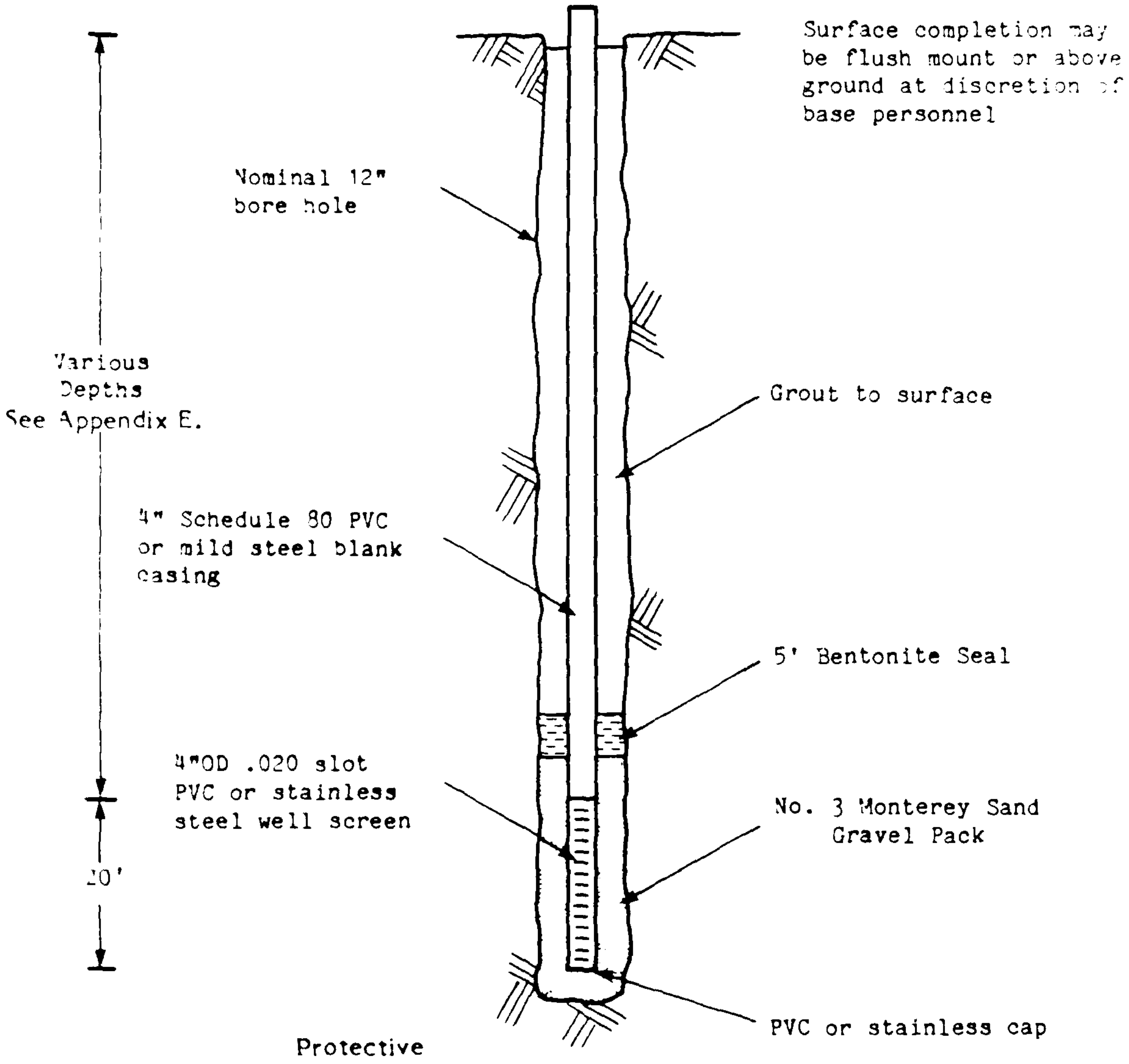
1. Drilling and Well Installation

All wells, except Well 1-01, were drilled by standard air rotary methods, using a D40K Driuteck drilling rig. Initially, AV was concerned that unconsolidated sediments in the shallow subsurface would potentially cave during the drilling process. To avoid this, the rig was equipped with a casing hammer, and drive casing was used to keep the hole open during drilling. After well installation, the drive casing was withdrawn, exposing the well to the formation. Gravel pack, bentonite, and grout were installed as the drive casing was removed.

Two drilling rigs were used for this portion of the project. The rig, previously described above drilled the hole, drove the outer casing, and installed the well casing and gravel pack. A second rig, equipped with large hydraulic jacks, jacked the drive casing out of the ground, for later use, and grouted the hole to the surface. Well 1-01 was drilled using standard mud rotary techniques. Samples for lithologic description were collected and rinsed by the on-site geologist at 5-foot intervals. Rig motion and penetration rate were also noted.

a. Well Installation

Water Development Corporation installed, under the supervision of AV's field geologist(s), a total of 20 wells to monitor the uppermost saturated zone at Beale AFB. All of these wells were constructed using stainless steel well screens with mild steel riser pipe. Steel wells were installed because the Air Force had decided that all sites could require long-term monitoring. Figure III-1 diagrams a typical monitoring well and Appendix E contains diagrams of all wells installed for this project, along with the lithologic logs of the borings.



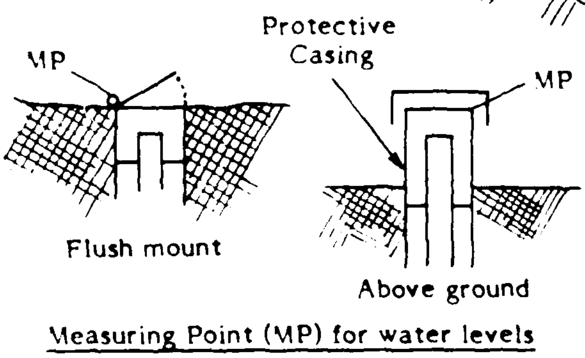


Figure III-1

Typical Monitoring Well

Beale Air Force Base

AeroVironment Inc.

AV gathered information on groundwater flow and gradients from the IRP Phase I study, from a groundwater monitoring program in place at the wastewater treatment plant, and from the state regulatory agencies. Well locations selected were either directly upgradient or downgradient of the potentially contaminated sites to be investigated.

Bore holes were drilled to about 20 feet below the water table (using the air rotary method, the water table was easy to identify). Well screens were placed 10-15 feet into the saturated zone, to allow for fluctuation in the water table. Thus the surface of the water table and the capillary fringe could be monitored for hydrocarbons or other light contaminants.

b. Well Development

Because the wells installed at Beale AFB were difficult to develop due to sediment, several methods were tried. Initially, Water Development Corporation attempted to bail and pump the wells to remove sediment and flush any remaining drill cuttings from the formation. This method worked on wells installed at Landfills Nos. 2 and 3, but was not successful on other wells. A second method, using a plunger-type bailer, did not achieve the desired results. Generally, the wells at Beale have very low yields. Most development techniques work by removing large amounts of water from the hole at high flow rates and bringing suspended sediment to the surface with the water. Water is usually removed until all the sediment has been suspended and removed. Because the wells produced so little water, it was difficult to suspend and remove the sediment.

After attempting several modifications to the standard air-lift technique, Water Development Corporation was able to obtain successful but slow results. The technique works on the Venturi Principle. A vacuum was created by passing air over a small opening in the suction line just above the water level. The vacuum then pulled water and sediment up out of the well through a pipe. An inflated bladder was used to isolate the bottom 20 feet of the hole and to prevent the introduction of air from the screened zone. Figure III-2 shows the method in more detail. This method proved successful, but usually took 12-18 hours of air-lifting per hole.

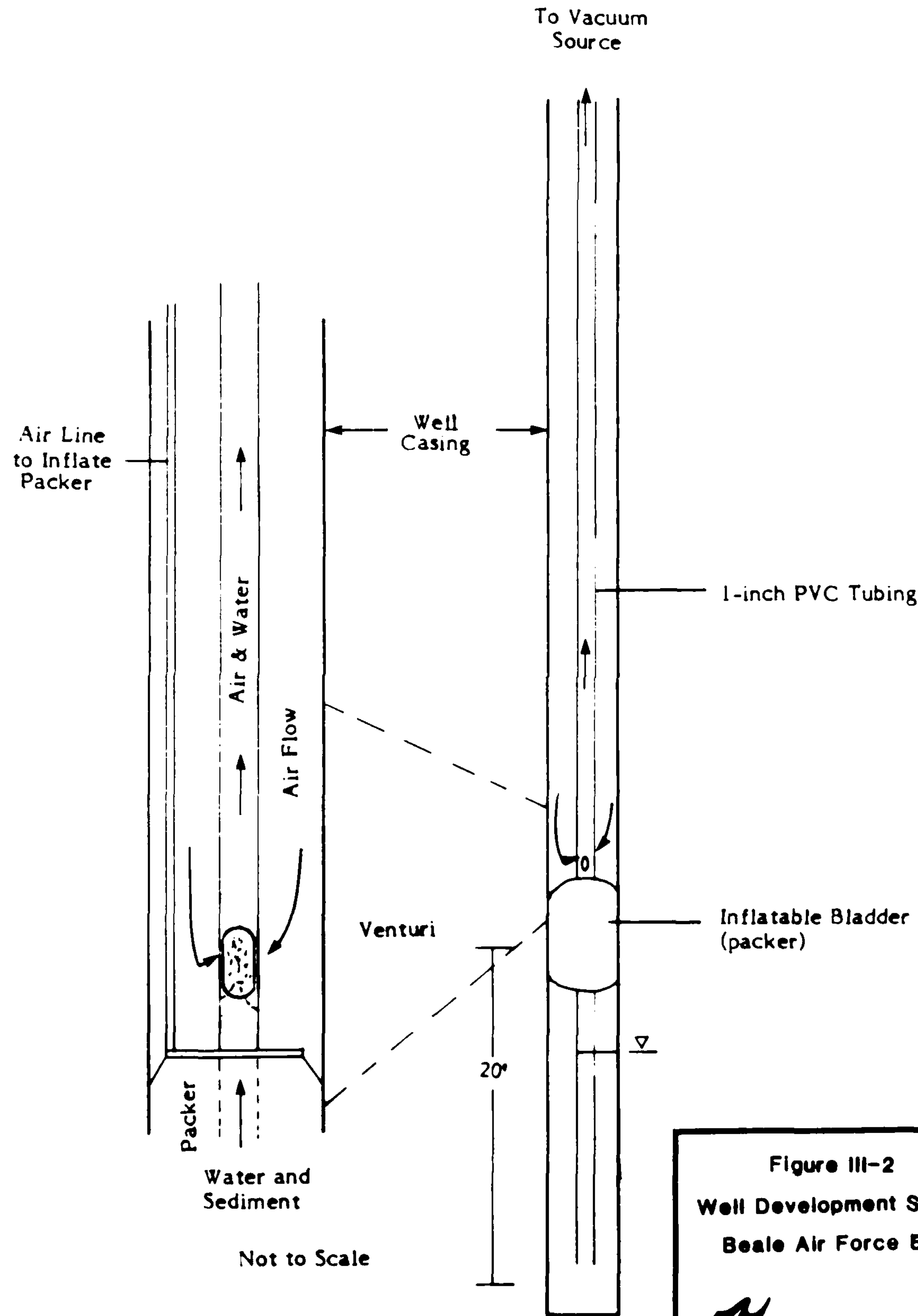


Figure III-2

Well Development System

Beale Air Force Base

AeroVironment Inc.

c. Surface Completion

The wells sited in the industrial area of the base or near the flightline were completed about one inch above the ground surface and placed in concrete "christie" boxes with locking steel caps to keep surface runoff water from entering the well. Five wells were completed in this fashion. The remaining wells extended 2-3 feet above ground surface. We shielded them with a steel guard pipe and lid set in a 4 feet x 4 feet x 4 inch concrete pad.

2. Groundwater Sampling Phase

AV collected two rounds of groundwater samples approximately three months apart. Similar collection procedures were used by both sets. Both included the wells drilled during Phase II, Stage 1, existing wells at the Photo Wastewater Treatment Plant (PWTP), and base production wells. Table III-I shows each set of samples.

AV collected one set of samples for analysis by AV's lab (Acurex) and a complete set of split samples for USAF OEHL. For each round, two field crews were mobilized: a well evacuation crew of two members and a sampling crew of two to three members. The evacuation crew initiated the operation by measuring the static water level in the well and then pumping five well volumes with a submersible impeller pump. While pumping, they recorded temperature, initial and final readings for water pH using a Research Model 211 pH meter, and conductivity using a Horizon Ecology Type 1840-10 conductivity meter. Initial and stabilized pH, temperature and conductivity values are presented at the end of Appendix H. If the well was a low water producer, or was inaccessible to the pumping vehicle, they used a 3-1/2-inch diameter, teflon hand bailer to remove the required volumes. Unless the well needed time to recover, the sampling crew immediately began the sampling procedure. Two members sampled the well with a 1-7/8 inch diameter stainless steel bailer and nylon rope pulley system, while the third documented the sampling. The volume of water collected depended on the types of analyses for which the sample was needed. Table III-2 shows types of analyses, size of samples, and preservatives required.

TABLE III-1. Sampling Timetable.

Soil Samples		
10/22/85	6 auger rig samples	Site 17
10/23/85	6 auger rig samples 4 auger rig samples	Site 17 Site 9
10/24/85	7 auger rig samples	Site 11
10/25/85	6 auger rig samples	Site 11
10/31/85	14 auger rig samples	Site 3
11/01/85	16 auger rig samples 2 auger rig sample	Site 3 Site 9
11/12/85	16 auger rig samples	Site 2
11/13/85	9 auger rig samples 8 auger rig samples	Site 12 Site 5
11/14/85	15 auger rig samples	Site 5
11/15/85	27 auger rig samples	Site 18
11/16/85	9 auger rig sample	Site 18
11/20/85	4 hand core samples 6 hand core samples 6 hand core samples	Site 7 Site 3 Site 8
11/21/85	7 hand core samples 6 hand core samples	Site 10 Site 17
11/22/85	12 hand core samples 7 hand core samples 1 surface grab samples 2 bottom sediment samples	Site 14 Site 11 Site 16 Site 3
11/23/85	5 bottom sediment samples	Site 1
04/16/86	7 hand core samples	Site 10
04/17/86	1 surface grab sample	Site 16
Water Samples		
Round 1		
11/19/85	4 surface water samples 4 bottom sediment samples 1 surface water sample	Site 13 Site 13 Site 17
11/23/85	4 surface water samples	Site 1
01/06/86	1 groundwater sample 1 groundwater sample 1 groundwater sample 1 groundwater sample	Site 4 Site 11 Site 10 Site 5

TABLE III-1. (con't)

01/07/86	3 groundwater samples 1 groundwater sample 1 groundwater sample 1 groundwater sample	Site 3 Site 8 Site 2 Site R2
01/08/86	1 groundwater sample 2 groundwater samples	Site 3 Site R2
01/09/86	4 groundwater samples 1 groundwater sample 1 groundwater sample 4 surface water samples 1 surface water sample	Site 15 Site 3 Site 6 Site 13 Site 17
01/10/86	2 groundwater samples 1 groundwater sample	Site 13 Site 6
Round 2		
04/14/86	3 groundwater samples 1 groundwater sample	Site 3 Site 1
04/15/86	2 groundwater samples 2 groundwater samples 4 groundwater samples	Site 3 Site 6 Site 15
04/16/86	2 groundwater samples 1 groundwater sample 1 groundwater sample 1 groundwater sample 1 groundwater sample 4 surface water samples 1 surface water sample	Site 13 Site R2 Site 2 Site 10 Site 11 Site 13 Site 17
04/17/86	1 groundwater sample 1 groundwater sample 1 groundwater sample 3 groundwater samples 3 surface water samples 1 surface water samples	Site 8 Site 4 Site 1 Site R2 Site 1 Site 3
04/18/86	1 groundwater sample 6 groundwater samples	Site 5 Base Production

TABLE III-2. Groundwater Sampling Requirements.

Parameters	Analysis Method	Sample Size	Preservatives
VOC (Volatile Organics)	EPA 601/602	40 ml	None
Oil & Grease Petroleum, Hydrocarbons	EPA 413.2 EPA 418.1	1 liter	1 ml Sulfuric Acid
Metals	EPA Series 200	500 ml	2 ml Nitric Acid
BNA (Base Neutral Acids)	EPA 625	4 liter	None
Phenol	EPA 420.1	1 liter	4 ml Phosphoric Acid and 1 g Cupric Sulfate
Lead	EPA 239.2	500 ml	2 ml Nitric Acid
Pesticides/Herbicides	SM 509 A&B (Standard methods)	4 liter	None

The first two bailers of well water were used to rinse the decontaminated sample bucket. Volatile organics (VOC) samples were taken first and poured directly from the bailer into the sample bottles. After collecting the VOC samples, the water for other parameters was collected in the sample bucket. After enough water had been collected to fill all the remaining bottles, the sample water was poured through a stainless steel funnel into the appropriate sample bottles. If the sample was to be analyzed for metals, the water was carefully filtered through a Geotech pressurized 0.45-micron filter with a glass pre-filter. After any required preservatives were administered and the sample bottles were sealed, labeled and immediately stored in iced coolers.

All sampling equipment was decontaminated between well samplings. This process included a wash with Alconox detergent, a rinse with drinking-quality water, and then a triple rinse with de-ionized water. The equipment was then wrapped in aluminum foil to ensure cleanliness. The well sampler (i.e., the crew member who handled the sample bailer) wore a new pair of latex gloves during the sampling at each well.

After the day of sampling all samples (including the 10% split samples for blind quality assurance purposes) were packed in the field and chain-of-custody forms were completed. One field blank was prepared for each sampling round. These samples were shipped via Greyhound Bus Lines to the laboratory for analysis.

3. Soil Sample Collection

The Water Development Corporation, under AV's supervision, drilled 38 hollow stem auger borings at eight of the sites on Beale AFB. The drilling locations were selected to allow sampling of worst-case contamination based on on-site observations in the upper soil at each site (with the exception of background holes). All necessary drilling permits were obtained for each drilling location. Most holes were about 15 feet in depth with soil samples collected at 3-foot to 5-foot intervals. The planned 30-foot boring at the Battery Shop dry well was not completed because of difficult drilling conditions and drilling access

problems. A two-man crew operated a Simco Model 2800S drill rig and collected samples under the supervision of AeroVironment's geologist. As each sample was brought to the surface, the geologist examined it, checked it for organic vapors, capped the ends sealing it for storage, and logged the soil description. Each sample was sealed quickly to avoid addition or loss of contaminants. Between samples, the drilling crew decontaminated equipment. Throughout the drilling and sampling operation, the geologist monitored ambient air for field crew safety.

AV used an 18-inch split spoon sampler to collect the soil samples from the borings (Figure III-3). This sampler was split down the middle and three 6-inch long, 2-inch OD mild steel tubes were placed inside it as liners. The sampler was lowered down the center of the hollow stem auger after the bit (or plug) had been removed. The sampler was driven 18 inches into the undisturbed soil directly below the open hole. Sampling always occurred ahead of the augers. The sampler was driven into the ground by a 140-pound hammer falling 30 inches. The field geologist counted the number of times the hammer fell to advance the sampler each six-inch segment. This number is called the blow count and gives some indication of the soil's stiffness. It is recorded on the boring logs in Appendix D.

When the sampler was driven into the ground, an 18-inch column of soil was pushed up into the rings. The sampler was then pulled out of the hole and opened. The three rings were marked with the depth to which they had been driven. The uppermost ring was discarded, because it often contained sluff material which fell into the bottom of the hole. The bottom two rings were prepared for laboratory analysis. The field geologist quickly removed the rings from the sampler, visually inspected the soil, covered both ends with aluminum foil, capped the ends with airtight plastic caps and sealed the caps with electrical tape. Afterwards, the sample was labeled for laboratory identification and logged on the boring log. After marking and logging, the field geologist stored the sample on ice in a picnic-type cooler. This method of sampling provided a basically undisturbed, airtight soil sample to be shipped to the laboratory.

The AV project team considers the "ring sampling" method used at Beale AFB to be superior to the traditional split-spoon sampling method used on

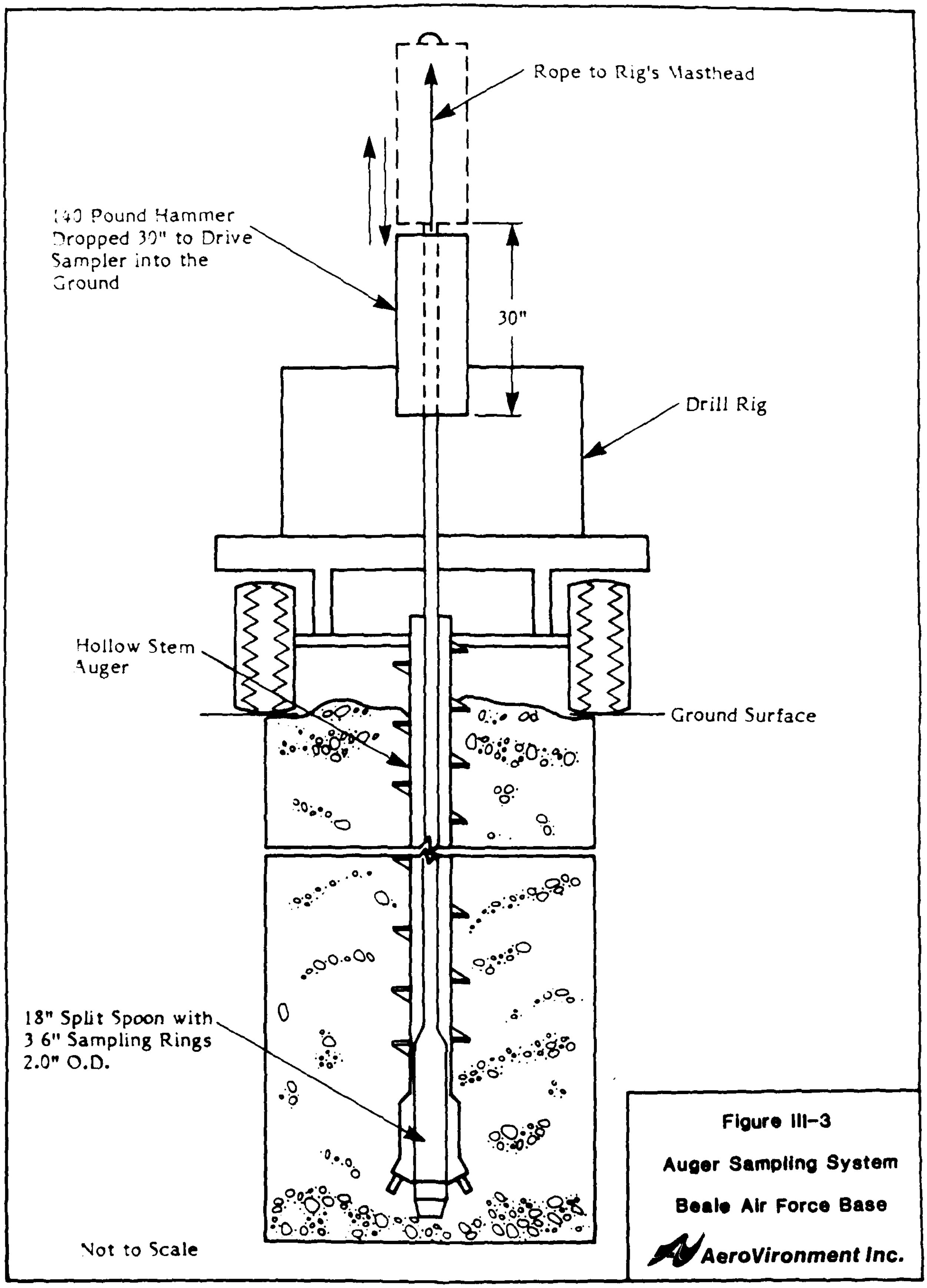


Figure III-3

Auger Sampling System

Beale Air Force Base

AeroVironment Inc.

many EPA drilling programs. Split spoons without rings require opening and mixing the soil sample, and transferring the sample into the sample jar. The ring method virtually eliminates the sampling errors of cross-contamination, sample mishandling, and loss of volatile compounds.

This method collects three discrete, six-inch samples at each sample location. The bottom ring was analyzed by AV's laboratory, Acurex, the middle ring was saved as a quality assurance (QA) sample and the upper ring (possibly filled with foreign soil) was discarded. Beale AFB personnel selected 10% splits from the QA samples for the OEHL Analytical Laboratory. AV sent 10% of the QA samples to Acurex as blind duplicates. Because the QA samples were actually from the bordering six-inch column of soil, they were not true splits. However, AV feels that the decreased chance of cross-contamination in the samples is more important than obtaining a true split. Soils six inches away should correlate well enough to check laboratory precision. (The QA program is discussed further in Section III-D.)

Between samples, the sampler was washed with Alconox detergent and water, rinsed with drinking quality water, and reloaded with new rings. (The steel rings used at Beale AFB were always new to prevent cross-contamination.) Prior to use, the rings were thoroughly cleaned with a paper towel to remove dust or moisture from the inner surfaces. The field geologist wore latex gloves whenever he handled the samples. The drilling tools were steam-cleaned between holes to avoid cross-contamination. All holes were grouted to the surface with cement at the end of drilling in each area.

Numerous shallow soil samples and sediments were collected at eight of the sites. Sediment samples were collected along stream banks. Most sampling locations were chosen to detect evidence of direct spillage/application of waste material to the ground's surface or runoff of contamination into drainage channels. Sediment and soil samples from drainage channels were collected at ground surface and one foot below the surface. Samples at the Biological Production Site, EOD, Best Slough, and the transformer area were collected only at the surface. These samples were collected on November 19-23, 1985, by two AV

personnel using a hand auger and hand-operated slide hammer sampler. The samplers were responsible for collection, logging, air monitoring and decontamination.

Hand-augered samples were obtained in much the same way as samples collected with the drill rig. The sampler (Figure III-4) held a single 6-inch cylinder, 2 inches in I.D., and was driven into the soil with a slide-hammer attachment. AV used sample collection rings machined from mild steel. After a sample was collected, it was removed from the sampler in its collection ring, the ends were covered with aluminum foil, capped, and taped. The sample was then logged. The sampler was washed with Alconox and water and rinsed with drinking quality water between samples. After the surface sample was taken, the boring was advanced to the desired depth with a hand auger and the soil sampler was again used to obtain a 6-inch core at the bottom of the hole. The hand auger was cleaned between holes.

As with the deep borings, AV team members consider the method of collecting shallow soil samples in undisturbed rings to be significantly better than more traditional methods. The traditional method involves excavating the soil, mixing it, and placing it in sample containers. That method provides multiple opportunities for loss of volatile constituents from or addition of outside materials to the soil. The method used at Beale AFB reduced the potential for sampling error.

Because the shallow samples at this site were depth-specific, the QA samples were taken from a separate hole immediately adjacent to the original hole. This allowed the "split" samples to be taken at the same depths as those taken for AV's lab (Acurex). As with the samples from the deep borings, the QA samples were not true splits but are considered to be less prone to field error. Beale AFB personnel selected 10% of the QA soil samples for shipment to the USAF OEHL lab. AV then submitted approximately 10% of the QA samples to Acurex as blind duplicates.

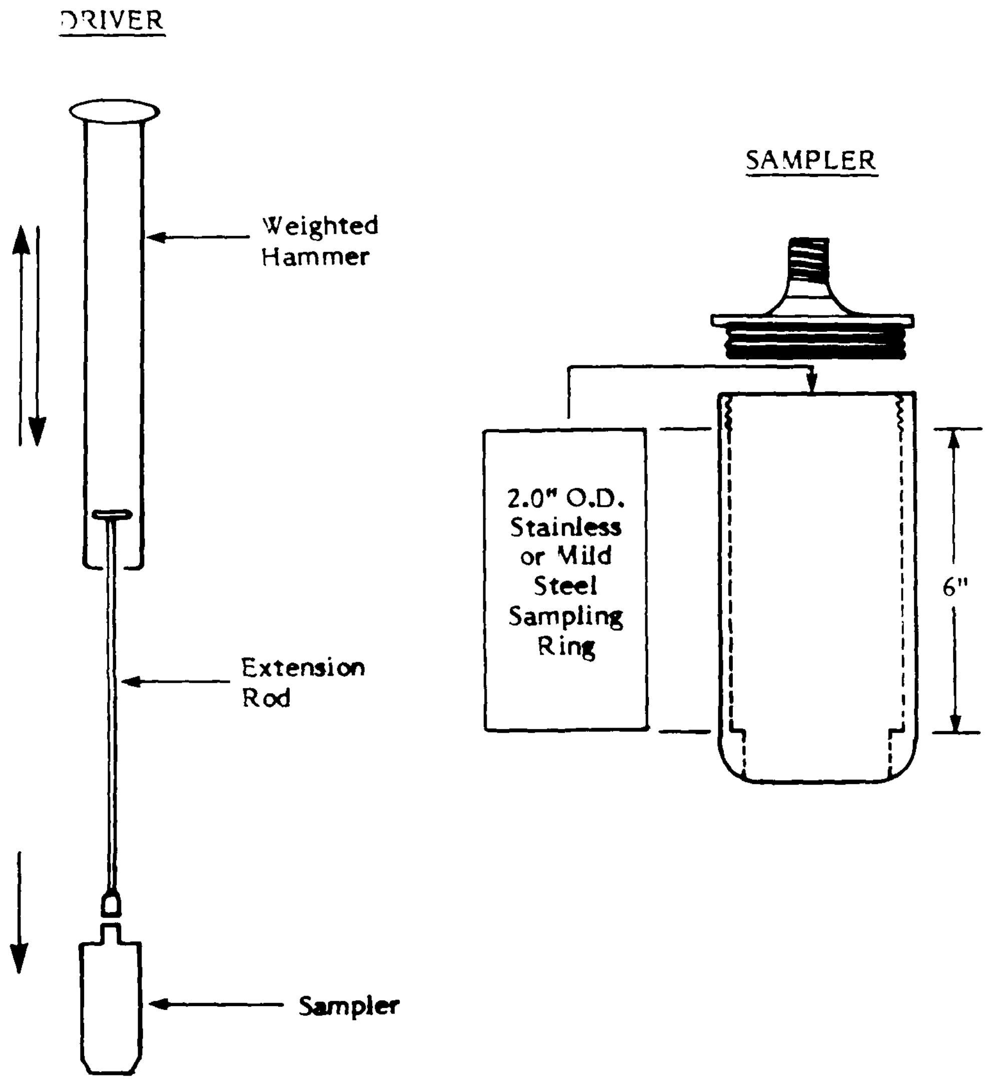


Figure III-4
Hand Sampling Device

Beale Air Force Base

AeroVironment Inc.

Background soil samples were collected at all sites except the Biological Production Site and the transformer area. Background samples were always taken in the general area of and at the same depth as the other samples to obtain similar soils but away from possible influence from the suspected contamination.

4. Surface Water Sampling

Surface water samples were collected from Hutchinson Creek at Landfill No. 1, from Best Slough, and from the West Drainage area. The samples were collected by hand, by placing the sample bottles into the water and allowing them to fill. At Best Slough and Landfill No. 1, water was collected about two feet from the bank of the creek. There was no visible flow during either sampling effort, but there was at least three feet of water in the streambed. Sediment samples were collected from the streambank at the same location as the surface water samples. The west drainage did not have any visible flow either. The drainage channel had about three feet of standing water at the headwall, but the water level dropped to about six inches after about 20 feet. Within about 1000 feet, there was no water in the channel.

5. Geophysical Program

On November 18 and 19, 1985, magnetometer and ground-penetrating radar (GPR) surveys were conducted at Landfill No. 1 to determine the boundaries of the disposal area, depth to buried refuse, and the presence of any metal such as buried drums. During this survey the magnetometer traversed approximately 13,000 linear feet and the GPR 7,660 feet.

6. Laboratory Interface

All samples collected at Beale AFB were analyzed at Acurex Corporation's laboratory in Mountain View, California approximately 250 miles from the base. Acurex's laboratory is certified by the California Department of Health Services and is a contract laboratory for the U.S. Environmental Protection

Agency. These samples were shipped via Greyhound bus and delivered to the laboratory overnight. Whenever possible, AV contacted the lab the morning after sample shipment to confirm receipt. The laboratory sample custodian checked all chain-of-custody documents against samples received, then signed each form and returned it to AV.

AV field personnel maintained close communication with laboratory personnel throughout the field program to ensure all samples shipped to the laboratory had arrived in good condition, to coordinate sampling activities with the laboratory ensuring samples could be processed within specified holding times, and to identify errors in sampling, preservation or analysis quickly, so that they could be rectified.

AV personnel visited the laboratory on several occasions to discuss the analytical methods, disposition of samples, potential problems, quality assurance, and data reporting. During the visits a check was made to verify that the sample holding time limits were not exceeded. Also, available test results were reviewed for completeness and consistancy. Any suspicious findings resulted in reanalyzing and sometimes resampling until satisfactory results were achieved.

An AV audit team conducted a quality assurance audit of the laboratory in April 1986. Its purpose was to evaluate the laboratory's methods and procedures, as they relate to the analysis of Air Force IRP samples, in order to ensure that the resulting data were true and valid. This audit is discussed as part of Section III.E, Quality Assurance Program.

C. Daily Field Activity Summary

The following section summarizes sampling activities and well drilling/ construction/development chronologically. Significant daily events and accomplishments have been noted. A condensed summary is presented in Table III-3. Figure I-3 shows the locations of the sites.

TABLE III-3. Daily Activity Log.

Date	Drilling Activity		Monitoring Well		Cumulative Total Wells Completed	Sampling Completed		
	Drill Hole	Footage	Construct	Develop		Sites	No. of Soils	No. of Waters
10-22						17	6	
10-23						17,9	10	
10-24						11	7	
10-25						11	6	
10-28	15-01	--			--			
10-29	15-01	117			--			
10-30	--	--	15-01		--			
10-31	15-02	40	15-01		1	3	15	
11-1	15-02	47	15-02		--	3,9	19	
11-2	15-03	60	15-02		2			
11-4	15-03	40	--		--			
	15-04	20	--		--			
11-5	15-04	80	15-03		3			
11-6	6-01	20	15-04		4			
11-7	6-01	70	6-01		5			
	6-02	60	--	15-02	--			
11-8	6-02	35	6-02	15-02	6			
	13-01	20	--	--	--			
11-9	13-01	80	--	15-01	--			
11-11	13-02	60	13-01	15-03	7			
11-12	13-02	40	13-01	15-04	--	2	16	
	13-01[1]	--	13-02	--	--			
11-13	--	--	13-02	6-02	8	12,5	20	
11-14	13-01[1]	--	13-01[1]	6-02	--	5	15	
	2-01	--	--	6-01	--			
11-15	2-01	115	13-01[1]	--	--	18	27	
11-16	3-01	95	2-01	--	9	18	9	
11-17	3-01	45	--	--	--			

TABLE III-3. (Continued)

Date	Drilling Activity		Monitoring Well		Cumulative Total Wells Completed	Sampling Completed		
	Drill Hole	Footage	Construct	Develop		Sites	No. of Soils	No. of Waters
11-18	3-01	20	--	--	--		5	
	3-02	100	--	--	--			
11-19	3-02	35	--	--	--	13,17	4	6(s)
11-20	3-03	100	3-02	6-02	10	7,3,8	29	1(s)
11-21	3-03	40	3-01	--	--	10,17	13	
	11-01	60	--	--	--			
11-22	11-01	80	11-01	--	--	16,3	24	
			3-01	--	--	14,11		
11-23	3-04	--	3-03	--	--	1	9	4(s)
11-24	--	--	3-03	--	11			
11-25	3-04	60	3-01	6-01	--			
	--	--	11-01	--	--			
11-26	3-04	77	11-01	--	--			
11-27	--	--	3-04	--	12			
12-2	3-01[2]	--	--	3-02	--			
12-3	--	--	3-01	3-02	13			
12-4	3-05	--	11-01		--			
12-5	4-01	140	11-01		14			
12-6	8-01	100	4-01		--			
12-7	8-01	50	4-01		15			
12-8	5-01	140	8-01		--			
12-9	3-05	140	8-01		16			
12-10	10-01	100	5-01		17			
12-11	1-01[3]	--	3-05		18			
12-12	Demobilize		10-01		19			
			Demobilize		--			
12-16				10-01				
12-17				10-01				

TABLE III-3. (Continued)

Date	Drilling Activity		Monitoring Well		Cumulative Total Wells Completed	Sampling Completed		
	Drill Hole	Footage	Construct	Develop		Sites	No. of Soils	No. of Waters
12-18				11-01				
12-19				03-02				
12-20				03-02				
12-21				03-01				
12-22				03-05				
12-23				03-05				
12-24 - 1-5				Sites 2, 4,8,5				
1-6				03-03		4,11,10,5		5(g)
1-7				03-04		3,2,8		6(g)
1-8				13-01		2,1,3		11(g)
1-9				13-02		17,3,15, 6,13		7(g),5(s)[4]
1-10						13,6		4(g)
3/26	01-01	90						
3/27	01-01	120	01-01					
3/29				01-01				
4/14								4(g)
4/15								8(g)
4/16							7	6(g), 4(s)
4/17							2	6(g), 4(s)
4/18								7(g)

1 = Redrill of 13-01; during original attempt the screen pulled up with casing. First attempt not counted except for days worked.

2 = Partial removal of cement plug. Hole drilled 25 feet too deep.

3 = Attempt to move to West Ditch; access road impossible to drive on with large drill rig due to wet conditions. Second attempt 12-20 to 12-24 failed due to mechanical problems.

4 = Partial resampling of surface water VOA samples.

Tuesday, October 22, 1985. AV and its drilling subcontractor, the Water Development Corporation, arrived on site to begin soil sample collection. Three borings were completed at Site 17 (Best Slough) using a hollow stem auger drill rig. Six soil samples were collected.

Wednesday, October 23, 1985. The sampling team completed three borings at Site 17 and two borings at Site 9 (Entomology Building 2560). Ten soil samples were collected.

Thursday, October 24, 1985. Two borings were completed at Site No. 11 (AGE Maintenance). A mechanical failure in the drill rig prevented further sampling for the day. The sampling team collected seven soil samples.

Friday, October 25, 1985. At Site 11, two borings were completed, and six soil samples collected. The sampling crew moved to Site 4 (the Battery Shop) to drill the 30-foot hole at that site. Difficult drilling conditions prevented the rig from advancing the hole to the desired depth. No samples were taken at Site 4.

Monday, October 28, 1985. The well-drilling crew from Water Development Corporation arrived and set up the drill rig on Site 15 (Landfill No. 3) for Well No. 15-01.

Tuesday, October 29, 1985. Well No. 15-01 was drilled to a total depth of 117 feet.

Wednesday, October 30, 1985. Construction of Well 15-01 began with setting the stainless steel screen and packing the sand.

Thursday, October 31, 1985. After placing the bentonite seal in Well 15-01 and grouting the hole to the surface, the crew moved the drill rig to Site 15-02 and drilled to 40 feet.

After repairs, the auger rig returned to the base and drilled four shallow borings at Site 3 (the FPTA). Fifteen soil samples were collected.

Friday, November 1, 1985. Drilling at Well 15-02 finished at 87 feet. The well construction crew placed the stainless steel screen, sand pack and bentonite seal in the hole.

The sampling team used the auger rig to drill three holes at Site 3 and one at Site 9 (Entomology Building 2560). Eighteen soil samples were collected before the drill rig broke down.

Saturday, November 2, 1985. Construction of Well 15-02 finished with grouting to the ground surface. Well 15-03 was drilled to 60 feet.

Monday, November 4, 1985. The drilling crew finished Well 15-03 at 100 feet. They then moved the rig to the site of Well 15-04 and began drilling. The development rig from Water Development Corporation arrived.

Tuesday, November 5, 1985. Drilling at Well 15-04 finished at 100 feet. The construction team set the screen, sand, and bentonite and grouted Well 15-03.

Wednesday, November 6, 1985. The drill rig was moved to Site 6 (Landfill No. 2) and Well 06-01 started. The construction team set the screen and grouted Well 15-04.

Thursday, November 7, 1985. The drilling crew completed Well 06-01 at 90 feet and moved to Well 06-02, which they drilled to 60 feet. The construction team trimmed the casing of Well 06-01 and completed construction. Development of 15-02 began.

Friday, November 8, 1985. After advancing Well 06-02 35 feet to a final depth of 95 feet, the drilling crew moved the rig to 13-01 (Landfill No. 1), behind the sewage treatment plant. Well 13-01 had been advanced to 20 feet, when drilling stopped for day because a metal shaving lodged in the driller's eye. The construction team built Well 06-02. The development of Well 15-02 was completed with a pad and locking cap.

Saturday, November 9, 1985. The drilling crew advanced Well 13-01 80 feet to completion at 100 feet. Well 15-01 was developed and a pad and locking cap put in place.

Monday, November 11, 1985. The drillers moved to Well 13-02 and drilled to 60 feet. The construction team placed the screen, sand and the bentonite seal in Well 13-01. The development team began pumping Well 15-03, but the pump broke.

Tuesday, November 12, 1985. Well 13-02 was drilled to 100 feet. The construction team attempted to pull the remaining casing from Well 13-01, but the screen came up with it. The bentonite seal had been placed in the casing, rather than below it, on November 11, 1985. All materials were removed from the hole. The construction team then moved to Well 13-02 and began construction. The drill team set up on Well 13-01 to redrill the hole. The development team pumped Well 15-04.

After repair, the auger rig returned again to complete the shallow borings. The sampling team drilled four holes at Site 2 (Photo Wastewater Injection Well) and collected sixteen samples.

Wednesday, November 13, 1985. A day of equipment problems. The clutch on the drill rig failed and the rig was removed to the staging area. The construction rig proved difficult to start, but the team put bentonite in Well 13-02 and grouted it. Although pumping of Well 06-02 began, the transformer blew and pumping stopped. AV suggested that a suction-type bailer be used for development.

The auger rig completed three holes at Site 12 (Entomology Building 440) and two holes at Site No. 5 (SR-71 Shelter). The sampling crew collected seventeen soil samples.

Thursday, November 14, 1985. The drill rig had been fixed, so it was used to ream Well 13-01. The drilling crew moved the rig to drill the injection

well. The construction teams put screen and sand in Well 13-01. The pump rig developed Well 06-01 and was then moved to 06-02, where the pump silted up. An alternate development method was again suggested.

The auger rig completed the remaining four borings at Site 5. Fifteen soil samples were collected.

Friday, November 15, 1986. The drilling crew sank Well 02-01 (Photo Wastewater Injection Well) to a total depth of 115 feet. The construction crew completed Well 13-01 and trimmed the drive casing. No development occurred.

The auger rig completed three borings at Site 18, (Bulk Fuels Storage) where twenty-seven soil samples were collected.

Saturday, November 16, 1985. After moving the rig from Well 02-01 to the fire protection training area, the drilling crew sank Well 03-01 to 95 feet. Well No. 02-01 was constructed; no wells were developed.

The sampling team completed the final boring at Site 18 and collected nine soil samples.

Sunday, November 17, 1985. Drilling continued on Well 03-01 from 95 to 140 feet, when an hydraulic fitting failed. The construction team trimmed the casing. No development took place.

Monday, November 18, 1985. Well 03-01 was extended to 160 feet without encountering noticeable water, although the water table was believed to be at 100 feet. The hole was temporarily abandoned. Well 03-02, 370 feet away, was drilled to 100 feet to try to locate water. Water suddenly came up in Well 03-01 to approximately 80 feet. No construction or development took place.

The USAF selected splits of soil collected on November 14, 15 and 16. AV then selected five QA samples to be added to the soil samples analyzed by Acurex.

The geophysical crew arrived at the site and staked the grid system at Site 13 (Landfill No. 1). The GPR survey was completed.

Tuesday, November 19, 1985. Because no water had been encountered at 100 feet, the drilling team continued to drill Well 03-02 to 135 feet. Water was encountered at approximately 115 feet, although the well was making water slowly. No construction or development took place.

The sampling crew collected surface water and bottom sediment samples at four locations at Site 13. The surface water sample from Site 17 (Best Slough) was also collected.

The geophysical crew conducted the magnetometer survey at Site 13. This concluded the geophysical activities.

Wednesday, November 20, 1985. Sounding Well 03-02 showed the water level up 6 feet from November 19 (SWL = 126 feet). The crew decided to set the screen at 112-132 feet The drill rig was moved to Well 03-03 and the well drilled to 100 feet, while the construction crew completed Well 03-02. The development crew tried pumping Well 06-02 (Landfill No. 2) but found it very silty. Bailing, instead of pumping, was suggested as a development technique.

The sampling crew collected sixteen surface soil samples from Site No. 7 (Biological Production) to be composited into four samples for analysis. They also collected six soil samples from three locations at Site 3 (FPTA) and seven soil samples from four locations at Site 8 (J-57 Test Cell). A field blank water sample was also prepared.

Thursday, November 21, 1985. The drilling team advanced Well 03-03 from 100 to a total depth of 140 feet. The well was making little water (approximately one quart per hour). The new fence posts made access to 03-03 difficult. The construction crew decided to plug the bottom of Well 03-01, then grout it up to the first aquifer at 105-135 feet. The drillers moved to Site 11 (AGE Maintenance Shop) and drilled 60 feet.

The sampling team collected seven soil samples from four locations at Site 10 (J-58 Test Cell) and six surface soil samples at Site 17 (Best Slough).

Friday, November 22, 1985. Well 11-01 was drilled to a total depth of 140 feet, after which the screen and sand pack were installed. The casing proved very hard to pull. Well 03-01 was grouted from 158-131 feet. No development occurred.

The sampling team collected twelve surface soil samples at Site 14 (Transformer Drainage), seven soil samples from four locations at Site 11, three surface soil samples for compositing from Site 16 (EOD) and, finally, two bottom sediment samples from the holding pond at Site 3.

Saturday, November 23, 1985. The drilling crew moved the rig from Well 11-01 to 03-04, then waited for a drive casing. Construction of Well 03-03 began; the casing was again very difficult to pull. No wells were developed. Rain of 1 inch plus fell.

Four surface water samples and five bottom sediment samples were collected from three locations at Site 1 (West Drainage). Four QA samples were also selected. No water was encountered in the West Drainage at the base property line.

Sunday, November 24, 1985. The team finished constructing and grouting Well 03-03. When it proved impossible to get the rig through the new fence posts, the team decided to cut one post, move the rig, then weld the post back. Again, 1 inch plus of rain fell.

Monday, November 25, 1985. Well 03-04 was drilled to 60 feet and the casing trimmed. After pumping excess water from Well 03-01, the team began to construct the well. Pulling the casing on 03-01 revealed a thin cement plug in it that needed to be reamed before the screen could be set. The construction team moved to Well 11-01 to work until Well 03-01 could be reamed by the drill rig. The pump truck became stuck in the mud.

Tuesday, November 26, 1985. Drilling at Well 03-04 finished at 137 feet. The construction team could not pull the casing on Well 11-01; they needed a larger hydraulic pump. The construction rig was taken to Woodland to upgrade the hydraulic pump. The pump truck was freed from the mud.

Wednesday, November 27, 1985. The drillers constructed Well 03-04 and began grouting it. The casing was at first easy to extract but then locked tight; 80 of the 132 feet of casing had to be abandoned. The remainder of the hole was grouted.

Thursday-Sunday, November 28-December 1, 1985. Thanksgiving break.

Monday, December 2, 1985. Well 03-01 was reamed out and Well 03-02 pumped.

Tuesday, December 3, 1985. Well 03-01 was constructed and its casing trimmed. After finishing the pumping at Well 03-02, the development crew worked on an alternative jet pumping system.

Wednesday, December 4, 1985. When drilling began at Well 03-05, the ground was very soft and muddy and the rig began to sink. The site was moved 20 feet and drilling began again. The drill hit a water main and the rig was again stuck in the mud. Base Civil Engineering was reluctant to define a suitable area for drilling at the J-57 Test Cell. The construction crew began Well 11-01, but the pump broke.

Thursday, December 5, 1985. The crew decided to drill Well 04-01 at the Battery Shop site, but waited 1-1/2 hours for Civil Engineering to approve the site and move the dumpsters. The drill crew completed 04-01 at 140 feet. The construction crew completed installation of Well 11-01.

Friday, December 6, 1985. Approval to drill Well 08-01 at Site 8 (the J-57 Test cell) was finally received. The original site was too muddy to drill. At the new site, the crew drilled to about 100 feet. The construction crew began and

completed 90% of Well 04-01. The construction rig became stuck in the mud outside the gate to Site 8.

Saturday, December 7, 1985. Drilling at Well 08-01 was completed at 150 feet and the drill rig cleaned to do Site 5 (SR-71 Shelter). After extracting the construction rig from mud, construction of Well 04-01 was completed.

Sunday, December 8, 1985. The drilling crew moved the rig to Site 5 (SR-71 Shelter) and completed the hole at 140 feet. The construction crew put the screen, sand and bentonite in Well 08-01.

Monday, December 9, 1985. After returning to Site 3 (FPTA), Well 03-05 was drilled to 140 feet. The construction team grouted Well 08-01. The drill cuttings were removed from Sites 4, 5 and 10.

Tuesday, December 10, 1985. The drilling crew moved the rig from the staging area to Site 10 (Test Cell J-58) and completed the hole at 100 feet. The construction rig installed Well 05-01.

Wednesday, December 11, 1985. After pulling the rig off Well 10-01 and preparing to move it to Site 1 (West Ditch), the drilling team waited 1.5 hours for access. As they finally proceeded toward the West Ditch, the drill rig got stuck on the "gravel" road and was hung up for 5.5 hours. It proved impossible to get the drill rig to the site under winter conditions unless the road was upgraded. The construction crew installed Well 03-05.

Thursday, December 12, 1985. The drill rig was returned to Woodland, California. The construction team installed Well 10-01. The development team arrived with the packer and compressor to try a new technique. No development had occurred since November 25, 1985.

Friday, December 13, 1985. One man undertook development at Well 03-04 using the packer and compressor to airlift water/sediment. The packer proved too small for the 4-inch casing and blew up in use.

Monday, December 16, 1985. Development resumed at Site 10 (J-58 Test Cell) with a larger packer.

Tuesday, December 17, 1985. Development of Well 10-01 was nearly completed. The alternative method proved acceptable but very slow.

Wednesday, December 18, 1985. After completing the development of Well 10-01, the development team moved to 11-01 (AGE Maintenance) and set up.

Thursday, December 19, 1985. The return hose on the packer collapsed. Rigid PVC was suggested as a replacement. The crew left Site 11-01, moved to 03-02 (FPTA), and began developing it using rigid PVC piping.

Friday, December 20, 1985. A small drill rig arrived to attempt drilling Well 01-01 (West Ditch). The drill opened a hole to 40 feet with a mud rotary. Development at Well 03-02 continued.

Saturday, December 21, 1985. The drill rig at Well 01-01 got down to 75 feet, but the bit kept plugging and the hole continued to cave. Lots of sand, a poor mud mixture and insufficient settling time in the mud pit added to the problem. Development of Well 03-01 began.

Sunday, December 22, 1985. At Well 01-01, the drill rig was inoperable most of day with a leaky water swivel; the hole continued to collapse. The drillers returned late in the day and worked till late at night extending the well to 100 feet. Development finished at Well 03-01 and began at Well 03-05.

Monday, December 23, 1985. Three hours were spent getting AFB passes. After drilling the hole at 01-01 to 140 feet, the fuel pump on the truck went out. The hole at Well 01-01 collapsed 20 feet and the drill bit got stuck. Development of Well 03-05 continued.

Tuesday, December 24, 1985. The drill crew returned to Site 01-01 at 4:00 a.m. and set up a cyclone to remove sand from recirculated drill mud. After

redrilling 10 feet, the bit stuck and the hydraulic line to the drive head broke. A berm was constructed around the hole to stop infiltration. The hole was then filled with thick mud and covered before the crew went home for Christmas. The development crew completed Well 03-05, moved to Well 11-01 (AGE Shop) and completed development there also.

Thursday-Sunday, December 26, 1985-January 5, 1986. The drilling contractor developed four wells by jet pumping. AV personnel were not on site. Due to weather conditions, they did not develop Sites 15 (landfills Nos. 3 & 25) and 6 with this method, but instead used bailing and pumping.

Monday, January 6, 1986. AV well sampling team arrived at Beale to collect the first round of groundwater samples. Base passes were obtained for the entire team. Samples were collected from Wells 04-01, (Battery Shop) 11-01, (AGE Maintenance) 10-01 (J-57 Test Cell) and 05-01 (SR-71 Shelter). A QA sample was also collected. Well 03-03 was developed using the jet pumping method.

Tuesday, January 7, 1986. Groundwater samples were collected from Wells 08-01 (J-57 Test Cell), 03-02, 03-01 (FPTA), 02-01 (Photo Wastewater Injection Well), Radian Well No. 4 (Photo Wastewater Treatment Plant), and 03-05. The development crew completed Well 03-04.

Wednesday, January 8, 1986. The sampling team collected groundwater samples from Well 03-03, Radian Well No. 2, Radian Well No. 3 and from 7 of the 9 base production wells. Radian Well No. 1 had a development bailer in it and two of the base production wells were nonfunctional, so none of these wells were sampled. Phenol samples were collected from Well 01-01 (West Drainage) and Radian Well No. 4 (Photo Wastewater Treatment Plant), because they had been forgotten on January 7. A QA sample was also prepared. Development of Well 13-01 (Landfill No. 1) was completed.

Thursday, January 9, 1986. The sampling team collected groundwater samples from Wells 15-01, 15-02, 15-03, 15-04 (Landfill No. 3), 03-04 (FPTA) and 06-01 (Landfill No. 2) and prepared a QA sample. Surface water samples from

four locations at Site 13 and Site 17 (Best Slough) were recollected for VOC and O&G analysis. After completing Well 13-02, the development crew left the base.

Friday, January 10, 1986. After collecting groundwater samples from Wells 06-02, 13-01 and 13-02 and preparing a QA sample, the sampling team left the base. The drilling subcontractor remained on base to finish the wells' surface completions.

Wednesday, March 26, 1986. AV's field geologist arrived at Beale AFB to supervise drilling of Well 01-01 (West Drainage). The well was drilled to 90 feet.

Thursday, March 27, 1986. Well 01-01 was completed to a depth of 120 feet.

Monday, April 14, 1986. The sampling crew arrived at Beale AFB to begin round 2 of groundwater monitoring well sampling. Groundwater samples were collected from Wells 01-01, 03-03, 03-04 and 03-01.

Tuesday, April 15, 1986. The field crew sampled Wells 03-02, 03-05, 06-01, 06-02, 15-01, 15-02, 15-03 and 15-04.

Wednesday, April 16, 1986. The sampling crew collected groundwater samples at Wells 13-01, 13-02, Radian Well No. 1, 02-01, 10-01 (J-52 Test Cell) and 11-01 (AGE Maintenance). Surface water samples No. 13-01 through 13-04 were taken from Hutchinson Creek. The crew also took soil samples at four locations at Site 10, each at depths of 0.5 feet and 1.5 feet.

Thursday, April 17, 1986. The sampling crew took groundwater samples from Wells 08 01 (V-57 Test Cell), 04-01 (Battery Shop), 01-01 (West Drainage), R2-02, R2-03 and R2-04 (Photo Wastewater Treatment Plant). Three surface water samples were taken from Site 1 (West Drainage) and one from the holding pond at Site 3 (FPTA). Two soil grab samples were taken from Site 16 EOD for compositing.

Friday, April 18, 1986. The crew took groundwater samples from Well 05-01 (SR-71 Shelter) and Base Production Wells 2, 3, 4, 5, 6 and 9. Field blanks were made up for QA/QC purposes. Base personnel chose their splits from the second sampling of Well 01-01 and Well 02-01 (Photo Wastewater Injection Well).

D. Field Instruments

During drilling, a gas alarm (O_2/explosimeter) was always on site to ensure that the breathing zone remained at an acceptable oxygen level. The drill hole and drill cuttings were monitored with an organic vapor meter (OVM), which measures the presence of volatile organic contamination. Once the well was drilled, a well sounder was used to determine the depth at which the water table was encountered.

The Gastech Protector Model 1562 portable gas alarm is a portable instrument for detecting combustible gas and oxygen deficiency. It can detect and indicate combustible gas concentrations up to the lower explosive limit. If gas concentration exceeds a preset level, it gives a characteristic audible signal. It also analyzes for oxygen over the range of 16 to 22% and gives a different signal if oxygen concentration drops below a preset level. It detects combustible gas by a diffusion head containing a catalytic element. An electrochemical oxygen cell installed in the same head with the combustible gas detector monitors the oxygen level.

The organic vapor meter used was an Analytical Instrument Development (AID) Model 590 OVM. The 590 is a photo-ionization instrument that uses a high-energy, ultraviolet radiation source to ionize a small portion of the sample introduced into the ionizing chamber. Ionization is initiated by the adsorption of the high energy photon by a molecule of vapor in the ionization chamber. If the molecule has an ionization potential equal to or less than the photon energy (h v), the molecule is ionized, forming a positive ion and an electron: $R + hv = R^+ + e^-$. This ion formation occurs in an electrical field between the collector electrode and the jet in the detector ionization chamber. Ions and

electrons that reach the electrodes contribute to a small ionization current that is measured with the electrometer of the instrument. The number of ions that reach the electrodes will be proportional at any given time to the concentration of the ionizable molecules within the detector, provided the linear range has not been exceeded. The instrument used during the project has a 10.0 electron volt energy level, which does not detect methane or other very light organic compounds. The OVM was checked and zeroed at the beginning of each field day.

The Powers Electric Company Well Sounder is a 200-foot electrical cable probe used to monitor the depth at which the top of the water table is encountered. The end of the cable holds two electrical probes connected by one foot of lead weights. When both probes are submerged in groundwater, an electrical current flows between the profies, and the meter registers this current in milliamperes.

During the groundwater sampling phase, pH and conductivity meters were used to characterize the sample water. After sampling, a filter was used to remove unwanted particulates from the metals samples. To measure pH, AV used an Orion Research Model 211 Digital pH meter. This meter has a combination electrode probe to determine the acid or basic properties of the sample water. AV calibrated the system daily with two buffer solutions and decontaminated the probe with deionized water after each use.

The Horizon Ecology Company Type 1840-10 Conductivity Meter measures total ionized substances in solution. It displays conductivity from 0-20,000 micromhos/cm^2 in five ranges. The temperature compensation is automatically corrected to 20^{o} C by a thermistor network internal to the probe, which is a self-contained dip style with tungsten electrodes. It was decontaminated with deionized water after each use.

The Geotech 2.4 Liter Barrel Filter is a pressure filtration unit that filters all particles of sizes down to 0.45 microns. During filtration, the barrel is sealed and gradually pressurized to 40 psi with nitrogen gas. Before reaching the 0.45 micron filter, the sample goes through a fiberglass prefilter to seive out any

large particles. This instrument is washed and decontaminated with distilled water after every use.

During the soil sampling phase, an organic vapor analyzer was used to measure the presence of volatile organic contamination. The Foxboro Century Model OVA-128 GC Portable is a flame ionization detector sensitive to the presence of organic vapors delivered to it by means of diaphragm pump. It monitors total organic vapors to parts-per-million (ppm) levels. The detector is composed of a hydrogen delivery system, a sample delivery system, and an electronic amplification and display system. In the survey mode, the air sample is delivered continuously to the detector chamber. When an organic vapor is exposed to the hydrogen flame via the air flow, the molecules ionize and a current flows between the detector electrodes. The current is proportional to the concentration of the vapor in the sample. Different compounds will ionize to varying extents in the flame, thus, the meter response of the OVA for a given compound is expressed relative to a methane standard.

Converse Consultants performed two geophysical surveys: (1) a magnetometer survey, and (2) a ground-penetrating radar survey. The magnetometer survey was conducted using an EG&G Geometrics G-856 proton precession magnetometer. This instrument measures the total magnetic field at a point by measuring the effects of the field on a proton-rich hydrocarbon fluid. It is able to measure disturbances in the Earth's local magnetic field caused by nearby ferrous metallic objects (e.g., pipelines, drums and powerlines).

Subcontractor Harding Lawson Associates performed the GPR survey under the direction of Converse using a Geophysical Survey Systems, Inc., Model SIR-8 radar. The GPR system transmits and receives a signal through an antenna towed along the ground surface. When the downward-traveling signal encounters a boundary between media with different electrical properties, some of the transmitted signal is reflected back to the surface, where it is detected by the antenna, amplified, and printed on a graphic recorder. A radar traverse provides a continuous graphic cross section of the electrical properties of subsurface soils along the survey line. The depth of investigation below the ground surface is a

function of the electrical properties of subsurface materials and the frequency of the radar antenna. For this survey, an 80 megahertz antenna was used to achieve maximum penetration into the landfill materials. Line control was provided by measuring tapes placed adjacent to survey lines. The approximately 7,700 lineal feet of GPR records obtained were evaluated in the office to locate buried objects and to estimate the thickness of the landfill cover.

E. Quality Assurance Program

To assure the quality of the measurement data, a quality assurance/ quality control (QA/QC) program for sampling and analysis was implemented. The objectives of this program were:

- o To monitor the precision of the sampling program by comparing blind field duplicate data with laboratory duplicate QC data.
- o To monitor the integrity of the analytical data. Blind quality control samples were used in order to eliminate the potential for laboratory bias.
- o To monitor the sampling methods for evidence of sample contamination through the use of field blanks.
- o To identify and minimize sources of error in the sampling program.

A key element of the QA/QC program was to establish routine quality control procedures not only at the instrumental analytical methods level, but also at the field sampling level. Sampling error can impact measurement data significantly, especially nonhomogeneous media such as soil, while analytical errors may account for a negligibly small portion of the total variance.

1. Field Sampling Quality Assurance

The field sampling program was carefully planned and executed. The field sampling personnel followed specific procedures throughout the sampling program to ensure consistency and minimize error. For the soil and groundwater sampling program, the following steps were taken to assure reliability:

- Well purging: All well-purging equipment was kept scrupulously clean, including rinsing with drinking quality water between use at different wells.

- Decontamination: All sampling equipment (stainless steel bailer, stainless steel bucket and funnel, pressure filtering apparatus, soil sampler) was thoroughly and consistently decontaminated between use at different wells.

- Sample containers: All sample bottles were cleaned to EPA protocols by the supplier and had Teflon-lined caps. Soil sampling rings were stainless steel, cut without oil.

- Sample preservatives: Preservatives were American Chemical Society certified reagent grade or better. Nitric acid for metals samples was analyzed spectral grade.

- Sample integrity: Sampling team personnel wore latex surgeon's gloves during sampling.

- Field duplicates: Ten percent of the samples were split in the field and submitted as blind duplicate quality control samples to monitor overall precision.

- Field blanks: For the groundwater sampling program, one blind field blank was submitted to the laboratory per sampling round. It was prepared with purified, pre-analyzed water. The blank water

was transferred to the stainless steel sampling bailer, which was rinsed twice, then sampled for (VOCs). The bucket was then filled using the bailer to sample for the remaining parameters. Samples requiring metals analysis were filtered through a 0.45 µm membrane and prefilter with the pressure filtration apparatus. Blank samples were preserved in the same manner as groundwater samples.

- Field Measurements: Conductivity and pH meters were calibrated at least once daily. Calibrations were checked periodically during the course of the sampling day with Standards traceable to the National Bureau of Standards (NBS), and instruments recalibrated if necessary. Groundwater temperature was measured with NBS specification thermometers, accurate to 0.1 ^{o} C.

- Field Observations: Thorough observations of each sampled well and soil boring were entered in a field logbook for later comparison with laboratory results.

- Sample storage and shipping: Samples were placed on ice in insulated coolers immediately after collection and were kept at approximately 4^{o}C during shipment.

- Chain-of-custody: Sample custody was maintained by the sampling team until shipment. Chain-of-custody forms documenting sample identification, date sampled, analyses required, sampling team members' names, signatures and shipping time and date were included in each sample shipment. Transported coolers were securely taped closed with strapping tape for shipment.

2. Laboratory Quality Assurance

The Acurex laboratory maintains an overall Quality Assurance Plan, which is included as Appendix F, as well as method-specific quality control procedures. In April 1986, an AeroVironment audit team conducted a system audit of the Acurex laboratory in Mountain View, California. The goals of the audit were:

- o To evaluate the laboratory's methods and procedures relating to the analysis of Air Force IRP samples to ensure resulting data were true and valid.
- o To identify areas that could be improved and to recommend measures to improve the quality of data for IRP samples.
- o To maintain and improve the exchange of information and ideas between Acurex and AeroVironment to assure a better product to the Air Force.

F. RELIABILITY OF SAMPLING

The field sampling program at Beale AFB included many procedures to assure that the resulting analytical data were valid. These procedures are described below.

1. Soil Sampling Reliability

Soil and sediment samples were collected using stainless steel cylinders, or "rings," measuring 2.5 inches in diameter and 6 inches in length. The rings were used as inserts for both the drill's split-spoon sampler and the hand-auger sampler. This method of soil sampling minimizes cross-contamination, sample mishandling and loss of volatile compounds.

Procedurally, the integrity of the soil samples was assured by several factors:

- Most of the sample rings used were new. Before use, they were wiped with lint-free tissue. Reused rings were washed with laboratory-grade detergent and rinsed thoroughly with hot drinking-quality water before reuse.

- Sample ends were covered with aluminum foil, then capped with plastic caps to prevent intrusion of organics into or adsorption of organics out of the sample.

- After sealing, logging and labeling, samples were immediately placed on ice insulated coolers. The laboratory received them within 16 hours of shipment.

- Between samples, the sampler was thoroughly decontaminated.

- Soil composites were sent to the laboratory as discrete samples and were not composited in the field. The laboratory composited the samples under controlled conditions to minimize the loss of VOCs or contamination of the sample.

- At the laboratory, the analyst removed and discarded approximately one inch of the soil from each end of the sample ring prior to subsampling for analysis. This practice ensures that if samples were not sealed properly, only the unaffected portion of the sample is analyzed.

2. Groundwater and Surface Water Sampling Reliability

In groundwater sampling for sensitive analytical parameters such as VOCs and heavy metals, it is important that the methodology not alter the

composition of the sample chemically or physically. The following factors impact sample integrity:

- o The adsorption of materials from or the leaching of materials into the sample by the sampling equipment.

- o A change in the pH state or the reduction or oxidation potential of the sample, which could precipitate dissolved minerals.

- o Degassing of VOCs from the sample as a result of aeration or pressure drops.

The stainless steel and Teflon construction of the sample bailer and transfer bucket minimizes the potential for adsorption of organics and for the introduction of contaminants into the sample. All sampling personnel coming into contact with the sample wore disposable latex gloves to prevent direct sample contact. Preparation of the bailer, bucket and funnel included rinsing them with two bailer volumes of water from the well prior to sample collection.

Several wells were sampled for heavy metals. To minimize oxidation and precipitation, the sample was handled gently to avoid aerating the sample by splashing. Purified nitrogen was used during filtration to prevent oxidation. Samples were filtered directly into high-density polyethylene bottles and immediately acidified.

The potential for degassing volatile organics during liquid sample collection with a bailer can be relatively high. To minimize this potential, the bailer was lowered into the well gently to prevent agitation, and VOC samples were taken from the first bailer by gently pouring them into 40-ml vials.

Surface water samples were collected by immersing sample bottles approximately 6 inches below the surface of the water to be sampled. This eliminated intermediate sample vessels and sample transfers. Because heavy metal

transport in surface water occurs by adsorption of contaminants onto suspended particulates, samples to be analyzed for metals were not filtered.

3. Field Quality Assurance Data

Overall, the quality of the field data package is good based on precision and accuracy of QA analyses. Field blanks for water samples and duplicates of water and soil samples were prepared by the sampling team in the field, then submitted blind to the laboratory. The selection of groundwater and surface water duplicates for the first sampling round was based upon suspected contamination and field observation, at a rate of 10% of the total number of samples collected. For the second round, field duplicates were selected to include samples known to be contaminated, based upon the first round results, in order to evaluate precision at levels above the level of quantification, which is typically five to ten times the detection limit.

Field soil boring duplicates were not "true" replicates; they were taken directly above the corresponding sample in the sampling barrel. Since soil contamination is often distributed unevenly throughout the soil, the results should not be expected to be identical. Hand auger duplicates were taken side-by-side within a few inches of each other.

Table III-4 gives the field quality control data compiled during the Beale AFB field program. These data are discussed below.

a. Volatile Organic Compounds, EPA Methods 601/602

Most of the "601/602" paired field duplicate results are less than ten times the method detection limit; at these levels, the precision is not as good as at higher concentrations. The precision, expressed as relative percent difference (RPD), is calculated using the following equation:

$$\mathrm{RPD} = \frac{X_1 - X_2}{\frac{X_1 + X_2}{2}} \times 100\%.$$

where X_1 and X_2 are paired duplicate values.

(THIS PAGE LEFT BLANK INTENTIONALLY)

TABLE III-4.
Beale Field Quality Assuran

601 8010 FIELD DUPLICATES
PAIRED RESULTS

SAMPLE ID	[illegible]		RPD	CHLOROFORM		RPD	TCE		RPD	TRANS-1,2-DCE		RPD	PERCHLOROETHYLENE		RPD	CHLOROMETHANE		RPD	DICHLOROBENZENE		RPD
8010 SOIL DATA (UG/G)																					
[illegible]	0.002	0.002	0.0%	0.00057	0.0004	35.1%															
[illegible]	[illegible]	[illegible]	51.9%	0.006	0.001	142.9%	0.008	0.01	22.2%	<0.0001	0.0001		0.002	0.002	0.0%						
18-[illegible]	[illegible]	[illegible]	0.0%	0.0004	0.0004	0.0%															
[illegible]	[illegible]	[illegible]	0.0%	0.0004	0.0004	0.0%	0.0002	0.002	163.6%				<0.0002	0.0002							
5-[illegible]	[illegible]	[illegible]	66.7%	0.0003	0.00065	142.9%															
5-[illegible]	[illegible]	[illegible]	40.0%	0.0005	0.0003	50.0%							0.0001	0.0003	100.0%						
5-[illegible]	[illegible]	[illegible]	40.0%	0.0004	0.0004	0.0%							0.0001	0.0003	100.0%	0.0008	<0.0008				
[illegible]	0.002	0.004	66.7%	0.00052	0.00055	5.6%							0.00009	0.00006	40.0%						
[illegible]	[illegible]	[illegible]	105.8%	0.001	<0.00005		<0.0001	0.0005					0.0002	0.0001	66.7%						
[illegible]	[illegible]	[illegible]	100.0%	0.0007	0.0005	33.3%	0.0001	0.001	163.6%	0.0002	0.0005	85.7%	0.004	0.002	66.7%				0.004	0.002	66.7%
[illegible]	0.004	[illegible]	66.7%	0.001	0.0004	85.7%	0.021	0.001	181.8%	0.003	0.0003	163.6%	0.0001	0.0001	0.0%				0.0002	<0.0003	
[illegible]	[illegible]	[illegible]	40.0%	0.0004	0.0004	0.0%							0.0001	0.0001	0.0%						
601 WATER DATA (UG/L)																					
[illegible]	[illegible]	[illegible]	[illegible]	0.16	0.20	21.6%	0.4	0.4	0.0%												
[illegible]	[illegible]	[illegible]	[illegible]	1.1	1.0	9.5%							0.2	0.2	0.0%						
[illegible]	[illegible]	[illegible]	56.[illegible]																		
[illegible]	[illegible]	[illegible]	100.[illegible]				0.2	0.2	0.0%				0.1	<0.0							
[illegible]	[illegible]	[illegible]	[illegible]																		
[illegible]																					
[illegible]	[illegible]	[illegible]	[illegible]				29	28	3.5%	<0.1	0.5										
MEAN			47.[illegible]%			41.[illegible]%			[illegible]						41.48%						
STD DEV			39.84%			49.60%			[illegible]						40.83%						

602 8020 FIELD DUPLICATES
PAIRED RESULTS

SAMPLE ID	BENZENE		RPD	TOLUENE		RPD	ETHYLBENZENE		RPD	CHLOROBENZENE		RPD	XYLENES		RPD	DICHLOROBENZENES		RPD
8020 SOIL DATA (UG/G)																		
[illegible]							0.0012	0.0005	82.4%									
17-01-S2																		
18-07-S5	0.0002	0.0003	40.0%	0.0003	0.0004	28.6%	0.0008	0.0009	11.8%									
5-01-S4				0.0002	0.0002	0.0%	0.0013	0.0004	105.9%	<0.0002	0.0001		<0.0002	0.0001				
5-03-S4	0.0004	<0.0002		0.0007	0.0002	111.1%	0.0009	0.0008	11.8%	0.0004	<0.0002					0.0009	<0.0004	
5-05-S2				0.0003	<0.0002		0.001	0.0007	35.3%									
5-06-S2	1.62	<0.05		0.11	0.14	24.0%	0.42	0.3	33.3%									
3-03-M1	<0.0002	0.0002		<0.0002	0.0003		0.0008	0.0006	28.6%									
3-24-S1				0.0005	0.0021	123.1%	0.0007	0.0009	25.0%									
3-25-S3				0.14	0.17	19.4%	0.38	0.57	40.0%				0.2	0.32	46.2%			
3-27-S2	0.0003	<0.0002		0.0018	0.0021	15.4%	0.0006	0.0009	40.0%									
2-04-S1	0.0003	<0.0002		0.0006	0.0003	66.7%	0.0013	0.0005	88.9%	0.0003	0.0002	40.0%	0.0003	0.0004	28.6%			
602 WATER DATA (UG/L)																		
13-01-S1				<0.2	0.2		0.7	0.8	13.3%									
89-09-S1				<0.2	2.0		0.4	0.6	40.0%									
04-01-S1				3.0	2.0	40.0%	1.4	0.6	80.0%									
03-04-S1				0.2	<0.2		0.8	0.6	28.[illegible]									
11-01-S2																		
13-02-S2																		
MEAN						47.6%			44.0%						37.4%			
STD DEV						41.1%			29.1%						8.8%			

602 FIELD BLANKS - WATER (UG/L)

SAMPLE ROUND	BENZENE	TOLUENE	EBENZ	CLBENZ	XYLENES	DICHLORO-BENZENES
1ST ROUND SURFACE WATERS	0.2	<0.2	<0.2	<0.2	<0.2	<0.4
1ST ROUND GROUND WATER	<0.2	0.2	0.7	<0.2	<0.2	<0.4
2ND ROUND COMBINED	0.2	<0.2	<0.2	<0.2	<0.2	<0.4

NA = NOT ANALYZED

RPD = RELATIVE PERCENT DIF

BLANK ENTRIES INDICATE ANA

TABLE III-4.
[illegible] Quality Assurance Program

	DICHLOROBENZENE		RPD	1,1,1-TCA		RPD	1,1,2-TCA		RPD	TRICHLORO-FLUOROMETHANE		RPD
[illegible]				0.0002	0.0003	40.0%						
[illegible]							0.008	0.0004	181.0%			
[illegible]										<0.0002	0.0003	
[illegible]										<0.0002	0.0002	
[illegible]				0.00006	0.00005	18.2%				0.00003	<0.001	
[illegible]				0.0001	<0.00003							
[illegible]	0.004	0.002	[illegible]									
[illegible]	[illegible]	<0.0003										
[illegible]				0.00004	<0.00003							
[illegible]				[illegible]	[illegible]							

601 FIELD BLANKS - WATER UG/L

SAMPLE ROUND	CH2CL2	CHCL3	111-TCA	TCE
1ST ROUND SURFACE WATERS	2.3	0.6	0.1	
1ST ROUND GROUND WATER	2.1		0.45	0.5
2ND ROUND COMBINED	0.2			

OIL AND GREASE, TOTAL PHENOLS FIELD BLANKS - WATER

SAMPLE ROUND	O&G MG/L	PHENOLS [illegible]
1ST ROUND SURFACE WATERS	[illegible]	[illegible]
1ST ROUND GROUND WATER	[illegible]	NA
2ND ROUND COMBINED	[illegible]	[illegible]

OIL & GREASE, PETROLEUM HC AND TOTAL PHENOLS
[illegible] DUPLICATES - PAIRED RESULTS

SAMPLE [illegible]	OIL & GREASE		RPD	PETROLEUM HC		RPD	TOTAL PHENOLS		RPD
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MEAN			[illegible]						[illegible]
STD DEV			[illegible]						[illegible]

NA = NOT ANALYZED

$$RPD = RELATIVE\ PERCENT\ DIFFERENCE = \frac{X1 - X2}{\frac{X1 + X2}{2}} \times 100\%$$

BLANK ENTRIES INDICATE ANALYTE BELOW METHOD DETECTION LIMIT

Table III - 4 (Con't.)

METALS FIELD DUPLICATES
PAIRED RESULTS

	As		RPD	Ba		RPD	Cd		RPD	Cr		RPD	Pb		RPD	Hg		RPD	Se		RPD	Ag		RPD
SOIL DATA (UG/G)																								
19-2-55	NA	NA		NA	NA		NA	NA		NA	NA		4	6	40.0%	NA	NA		NA	NA		NA	NA	
3-01-M1	NA	NA		NA	NA		NA	NA		NA	NA		13	15	14.3%	NA	NA		NA	NA		NA	NA	
3-04-51	NA	NA		NA	NA		NA	NA		NA	NA		17	15	12.5%	NA	NA		NA	NA		NA	NA	
3-05-53	NA	NA		NA	NA		NA	NA		NA	NA		14	13	7.4%	NA	NA		NA	NA		NA	NA	
3-07-52	NA	NA		NA	NA		NA	NA		NA	NA		11	13	16.7%	NA	NA		NA	NA		NA	NA	
WATER DATA (UG/L)																								
1-03-M1	30	<10		270	170	45.5%	<10	<10		30	20	40.0%	180	100	57.1%	<1	<1		<10	<10		<10	<10	
13-01-61	<10	<10		<50	<50		<10	<10		<10	<10		<20	<20		2	<1		<10	<10		<10	40	
13-4-M1	<10	<10		<60	<60		<10	<10		<10	<10		<20	<20		<1	<1		<10	<10		<10	20	
13-01-62	<10	<10		140	50	94.7%	<10	<10		<10	<10		<20	<20		<1	<1		<20	<20		<10	<10	
4-01-61	<10	<10		160	60	90.9%	<10	<10		<10	<10		<20	<20		<1	<1		<10	<10		<10	<10	
BP-09-61	<10	<10		70	70	0.0%	<10	<10		[illegible]	[illegible]		<20	<20		<1	<1		<10	<10		<10	<10	
MEAN						57.8%									24.7%									
STD DEV						38.6%									17.8%									

NA - NOT ANALYZED

METAL FIELD BLANKS - WATER UG/L

SAMPLE ROUND	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
1ST ROUND SURFACE WATERS	20	<60	<10	<10	<20	<1	<10	<10
1ST ROUND GROUND WATER	<10	<50	<10	<10	<20	<1	<10	<10
2ND ROUND COMBINED	<10	50	<10	<10	<20	<1	<20	30

HERBICIDE METHOD 509B FIELD DUPLICATES

SAMPLE ID	
12-01-54	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
9-02-51	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
13-01-61	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
13-04-M1	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
17-01-52	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
15-04-62	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
13-02-62	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT

HERBICIDE METHOD 509B FIELD BLANKS

SAMPLE ID	
1ST ROUND SURFACE WATERS	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
1ST ROUND GROUND WATER	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
2ND ROUND COMBINED	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT

EPA 625 (BNA) FIELD BLANKS - WATER UG/L

SAMPLE ROUND	PHENOL	BIS(2-ETHYLHEXYL-PHTHALATE
1ST ROUND GROUND WATER	4	5
2ND ROUND GROUND WATER	<2	14

PESTICIDE METHOD 509A FIELD DUPLICATES

SAMPLE ID	
12-01-54	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
9-02-51	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
13-01-61	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
13-04-M1	LINDANE 0.09/0.04 UG/L
17-01-52	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
15-04-62	LINDANE 0.12/0.10 UG/L
13-02-62	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT

PESTICIDE METHOD 509A FIELD BLANKS

SAMPLE ID	
1ST ROUND SURFACE WATERS	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
1ST ROUND GROUND WATER	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT
2ND ROUND COMBINED	NO COMPOUNDS REPORTED ABOVE METHOD DETECTION LIMIT

PCB METHOD 608 FIELD DUPLICATES

SAMPLE ID	
14-10-H1	NO AROCLORS REPORTED ABOVE METHOD DETECTION LIMIT

Precision for VOCs was difficult to assess because of the limited QA/QC data for samples having VOC concentrations above the Level of Quantification (LOQ). A field duplicate of groundwater sample 13-02-G2 showed good correlation for TCE with an RPD of 3.5%, a sample significantly above the LOQ for TCE. RPDs for ethylbenzene and toluene in soil and water split samples ranges from 19%-46% for levels above the LOQ. This precision is acceptable, though insufficient data is available to assess the precision for all analyses accurately.

Certain compounds detected in the groundwater and soil samples are normal laboratory background contaminants, including methylene chloride and ethylbenzene. Precision for these compounds is poor for field duplicates (up to 133% RPD for methylene chloride); this lack of reproducibility is not attributable to sampling error.

Laboratory precision based upon laboratory duplicates is comparable to field duplicates. Again, the duplicate data is inconclusive due to the low levels of analytes in the samples.

The water sample field blanks analyzed by EPA Methods 601 and 602 indicate no significant levels of sample contamination. Comparison of field and laboratory blanks shows more contaminants in the field blanks than in the laboratory blanks. Aside from methylene chloride, which is ubiquitous in the laboratory, chloroform, 1,1,1-trichloroethane and trichloroethylene were present at low levels in both the field and laboratory blanks. Levels detected in blanks are well below the LOQ, i.e., the level considered significant. Based upon this comparison of field and laboratory blank data, no significant field-induced VOC contamination has occurred.

Samples collected from several monitoring wells during the first round of groundwater sampling had elevated concentrations of toluene -- up to 16 µg/l. Concentrations did not appear in samples from the second round. Field documentation indicates all wells with elevated toluene levels had been evacuated by pumping, while the remainder of the wells were evacuated by hand bailing. The

source of contamination was identified as the electrical tape securing the pump's power cord to the PVC discharge pipe. The tape never came into direct contact with the groundwater; however, water from the discharge pipe may have run down the length of the pipe when the pump was removed from the well, causing contamination. The field sampling team had prepared a sample with a two-inch section of the electrical tape and purified water in a VOC vial to determine whether the tape would, under worst-case conditions, affect the sample. No Method 601 compounds were detected, but a high level of toluene was found. The use of electrical tape was discontinued for the second round of sampling, and toluene was not detected in any further samples.

b. Oil & Grease (O&G), Petroleum HC

Most of the soil oil & grease (O&G) duplicates were below the limit of detection. However, duplicate pairs with O&G levels above detection showed inconsistent precision, ranging from 0.0% RPD to 164% RPD. The extreme paired values were 4000 μg/g and 400 μg/g. Reanalysis by the laboratory yielded similar results. This disparity is most likely due to the inhomogeneity of the contamination in the soil. Laboratory soil O&G duplicates showed better precision, which is to be expected as the duplicate is taken from the same sample container. Overall, the field QA/QC duplicates confirmed the presence of O&G contamination.

Water O&G duplicates also showed some variation: precision ranged from 5% to 173% RPD. Laboratory duplicate data was limited; the entire contents of a one-liter sample bottle were used in the analysis. However, the single laboratory duplicate had an RPD of 139%, indicating the variance may be laboratory and/or sampling error. Most of the samples had very low levels of O&G, thus the significance of the variation is considered to be minimal. Field water blank samples showed detectable levels of O&G, to a maximum of 3.6 mg/l for the first sampling round. This level is higher than many of the reported sample values and may indicate field-induced contamination. Laboratory blank samples reported detectable levels of O&G, but at much lower concentrations.

c. Total Phenolics

Field QA/QC data indicate that the total phenolics results are of poor quality. Precision ranges from 43% to 133% RPD. Even at relatively high contamination, such as the paired results 80 µg/l and 30 µg/l for samples BP-09-G1, the data are not reproducible. Field water blank samples and reported total phenolics values of 17 µg/l and 9 µg/l for the two sampling rounds indicate sample contamination. Given the inconsistency of the total phenolics data from the water samples, concentrations were not considered significant unless the values were above 20 µg/l for both rounds of groundwater and surface water samples. Field duplicate results for soil were below detection, therefore precision could not be determined. However, no soil samples showed significantly elevated levels of total phenolics.

d. Metals

Limited field duplicate data above the LOQ were available for metals. Precision was relatively good for lead and chromium and slightly poorer for barium, though none of the concentrations were significantly elevated above environmental background. Field blanks showed no sample contamination.

e. Pesticide/Herbicides (SM 509 A&B)

Lindane was detected in two of the field master duplicate samples, with acceptable reproducibility for the low levels found. No other detectable levels of pesticides or herbicides were found in the field duplicates or blanks.

f. Base/Neutrals and Acid Extractables (EPA 625)

Bis (2-ethylhexyl) penthalate was detected in most of the soil and water samples at levels below normal laboratory background. Phenol was detected in the first round groundwater field blank at 4 µg/l, which is significant since the DOHS action level for phenol is 1 µg/l. Phenol was detected in several wells, but

the results are not conclusive due to the analytical method's high method detection limit (2 µg/l) and the blank contamination. Further sampling and analysis is recommended, using an analytical method more sensitive to phenol (e.g., EPA 608).

g. PCBs

No PCBs were detected in the field soil duplicate samples. A laboratory duplicate of a PCB-contaminated sample from Site 14 had paired results of 5.3 and 7.4 µg/g, showing good reproducibility.

5. Summary

Due to the limited amount of field duplicate data for samples having elevated levels of analytes, field precision was difficult to determine for many parameters. However, results for total phenolics (EPA 420.1), oil & grease (413.2) and phenol (EPA 625) in field duplicates or field blanks indicated that the sample results for those parameters should not be interpreted as accurate quantifications, but as indicators to identify the presence of these compounds. Otherwise, the data package was satisfactory in qualifying and quantifying the analytes of interest for this investigation.

IV. DISCUSSION OF RESULTS AND SIGNIFICANCE OF FINDINGS

A. Discussion of Results

1. Geology

Beale AFB is on the eastern edge of the Sacramento Valley. The terrain ranges from relatively flat floodplains in the west to the foothills of the Sierra Nevada Mountains in the east. The formations encountered during the drilling program were deposited as outwash from streams that originated in the mountains to the east. They dip gently toward the center of the valley to the west.

Three cross-sections have been generated from the drilling data to illustrate the stratigraphy found beneath the base. Figure IV-1 shows the locations of the three sections drawn for Beale AFB. Figures IV-2, 3, and 4 are the cross-sections themselves, which were drawn using information from the well logs included in Appendix E.

The Victor Formation (mapped as Qv on the geologic cross-sections) is uppermost. It is unconsolidated conglomerate with variable amounts of clays, silts, sands, and gravels. Generally, it is found as silty sands and gravels with occasional clay or gravelly clay zones. The Victor Formation was found in the northwest area of the base near the flightline. It appears to pinch out south of the runway and was not found in well borings near Landfill No. 1 in the southwest corner of the base. The formation thickens to the west and has been mapped over large areas to the west and southwest of the base (USGS, 1980). In many areas, it is known to develop a hardpan two to three feet below the surface. This hardpan layer, if it has not been breached by trenching, inhibits infiltration from the surface.

The Laguna Formation (Qtl) is found directly below the Victor Formation and may be up to 12 feet thick. Where the Victor is absent, the Laguna is the uppermost formation encountered. The Laguna is a heterogeneous mixture of interbedded sands, clays, clayey sands and gravels. The matrix material is clay

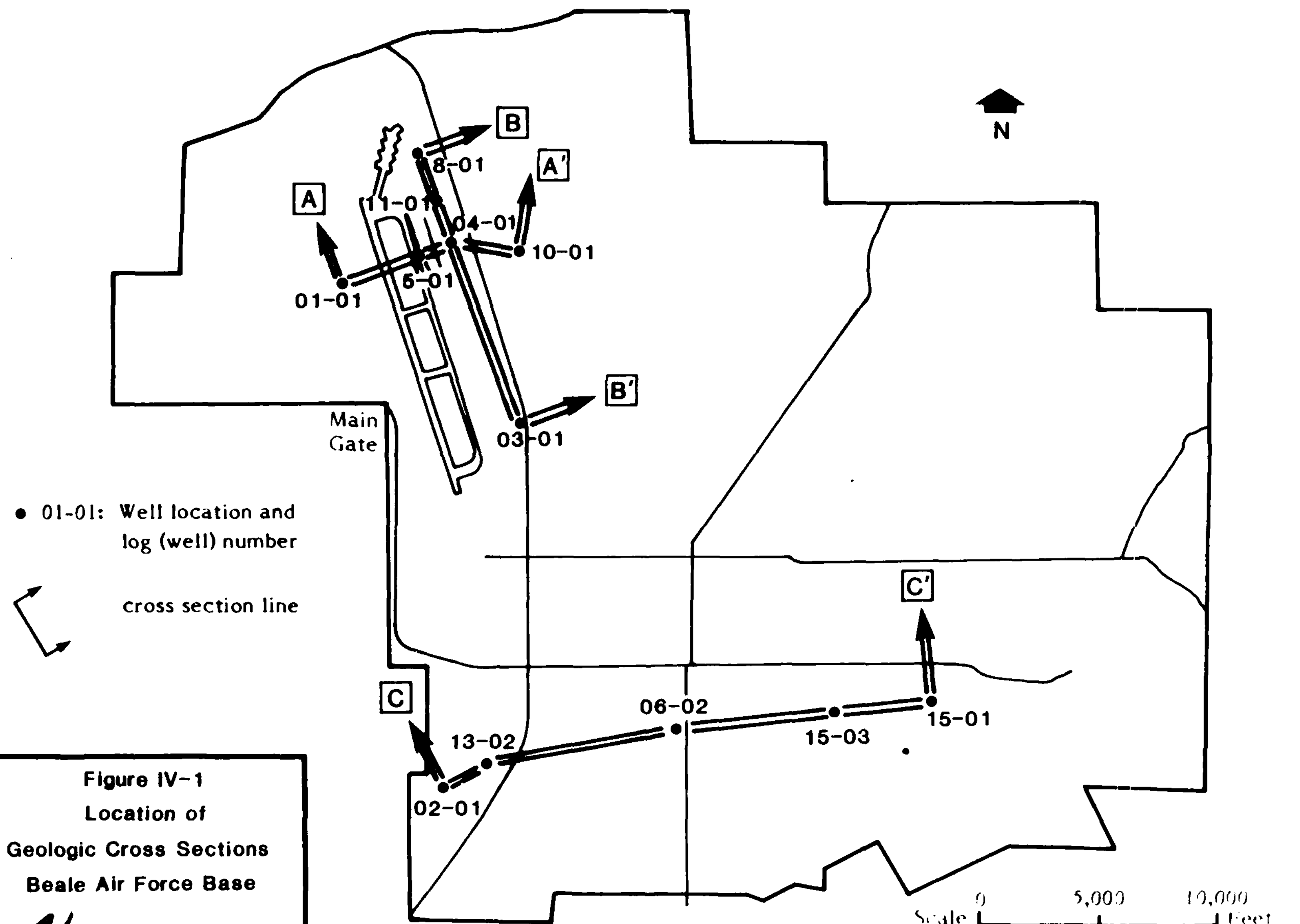
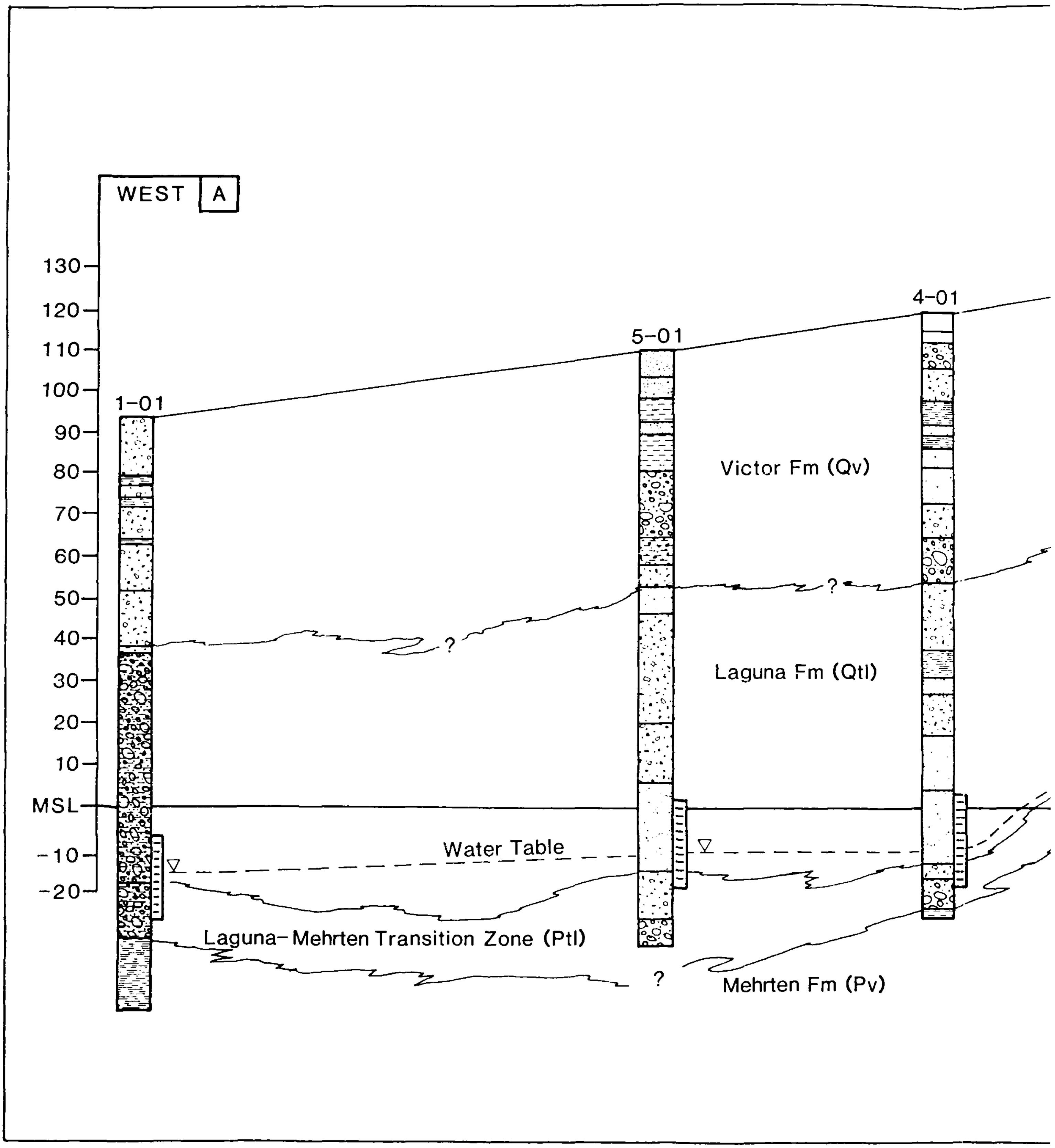


Figure IV-1
Location of
Geologic Cross Sections
Beale Air Force Base

AeroVironment Inc.



WEST
A
130
120
110
100
90
80
70
60
50
40
30
20
10
MSL
-10
-20
1-01
5-01
4-01
Victor Fm (Qv)
Laguna Fm (Qtl)
Water Table
Laguna-Mehrten Transition Zone (Ptl)
Mehrten Fm (Pv)
?

86-59

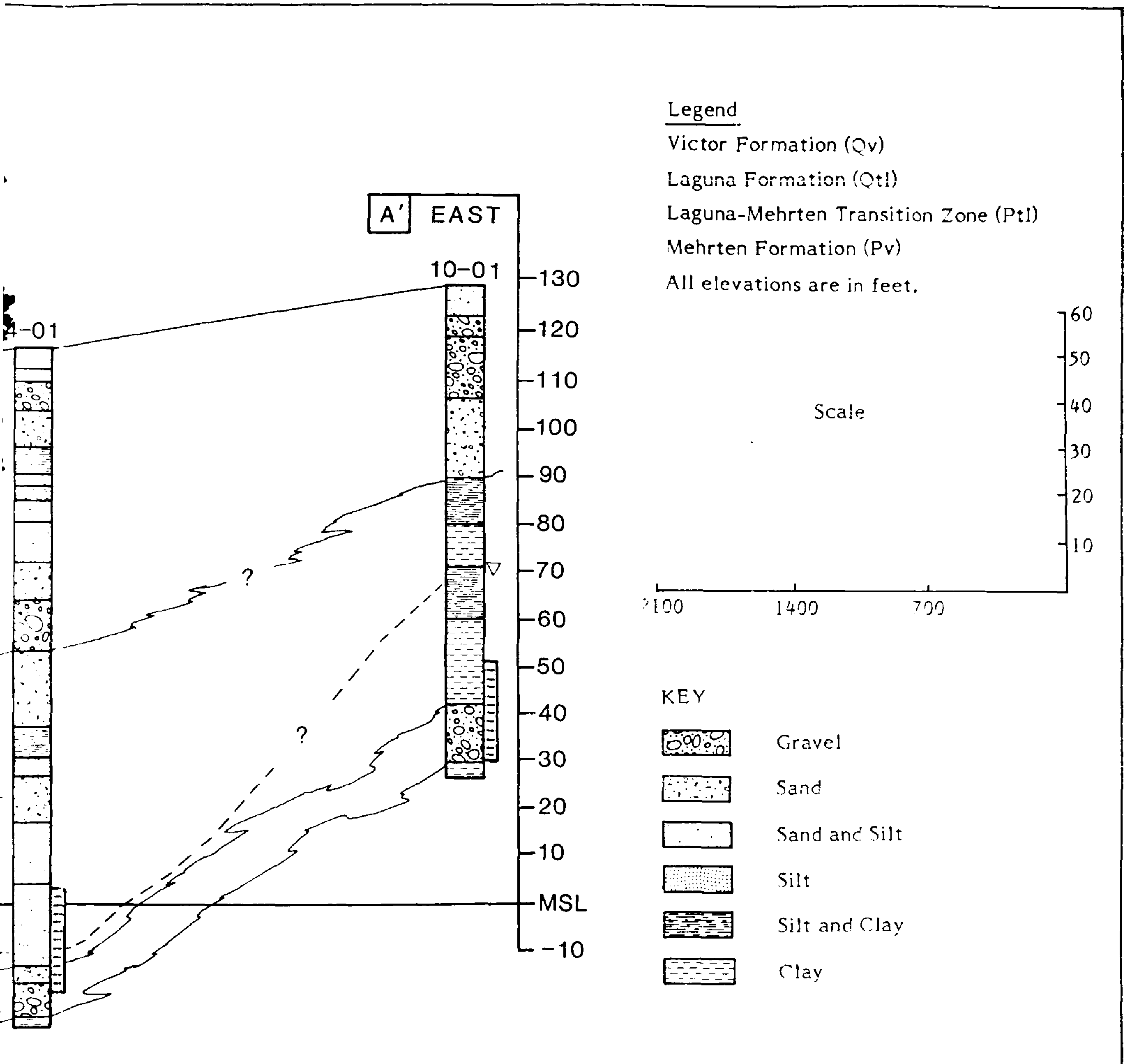
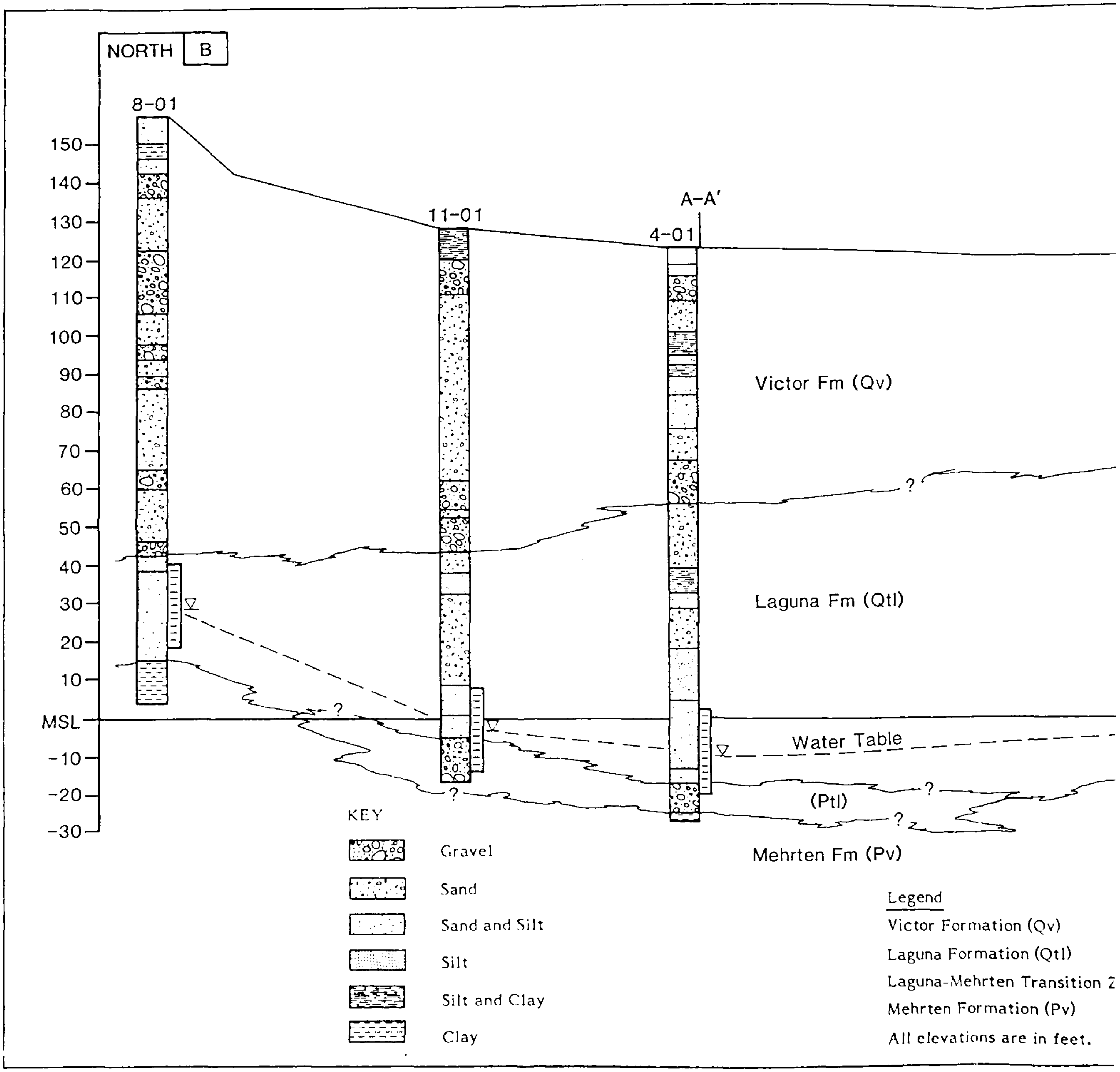


Figure IV-2

Geologic Cross Section A-A'

Beale Air Force Base

AeroVironment Inc.



NORTH
B
8-01
11-01
4-01
A-A'
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
MSL
-10
-20
-30
Victor Fm (Qv)
Laguna Fm (Qtl)
Water Table
(Ptl)
Mehrten Fm (Pv)
KEY
Gravel
Sand
Sand and Silt
Silt
Silt and Clay
Clay
Legend
Victor Formation (Qv)
Laguna Formation (Qtl)
Laguna-Mehrten Transition Z
Mehrten Formation (Pv)
All elevations are in feet.

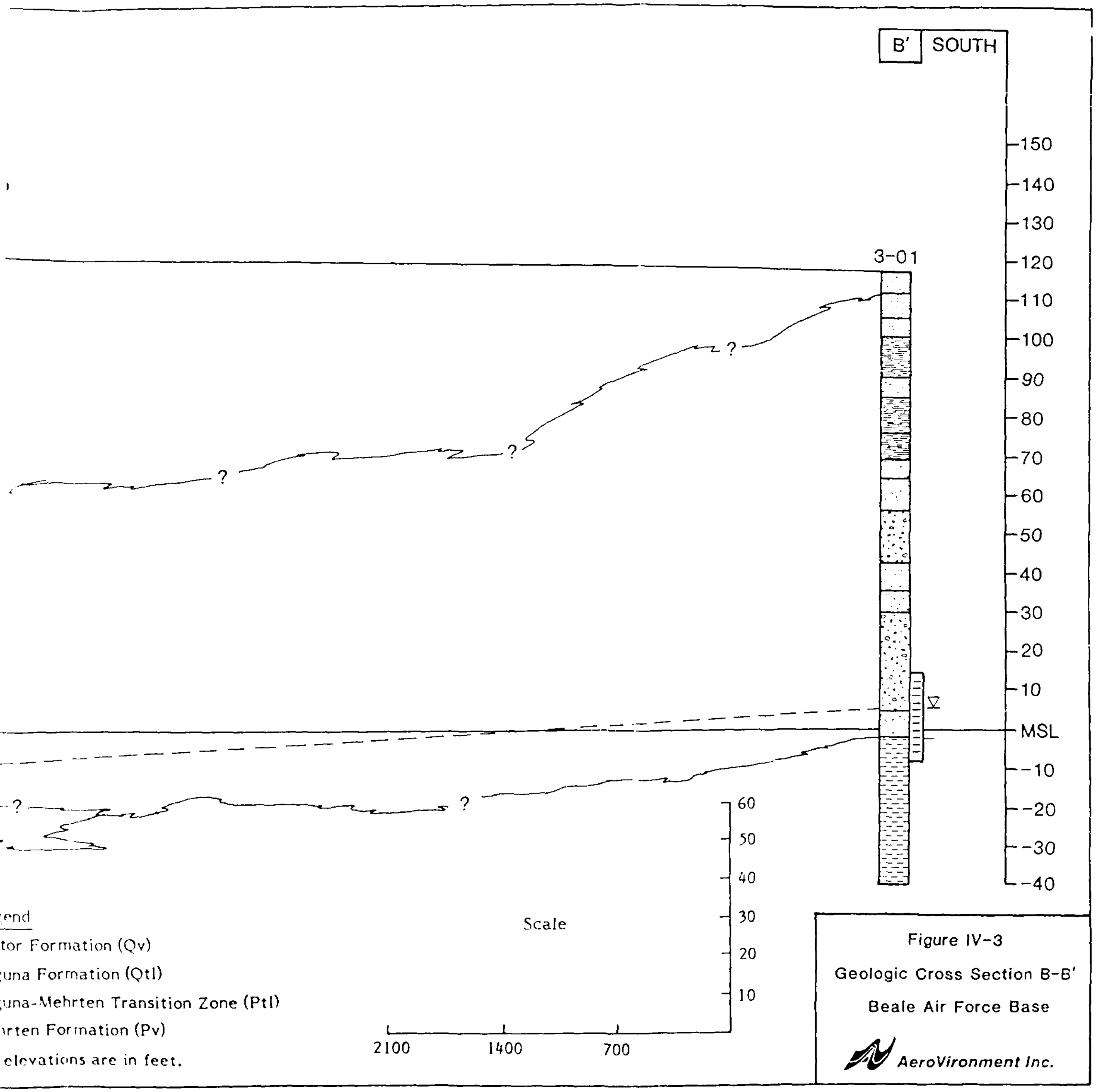
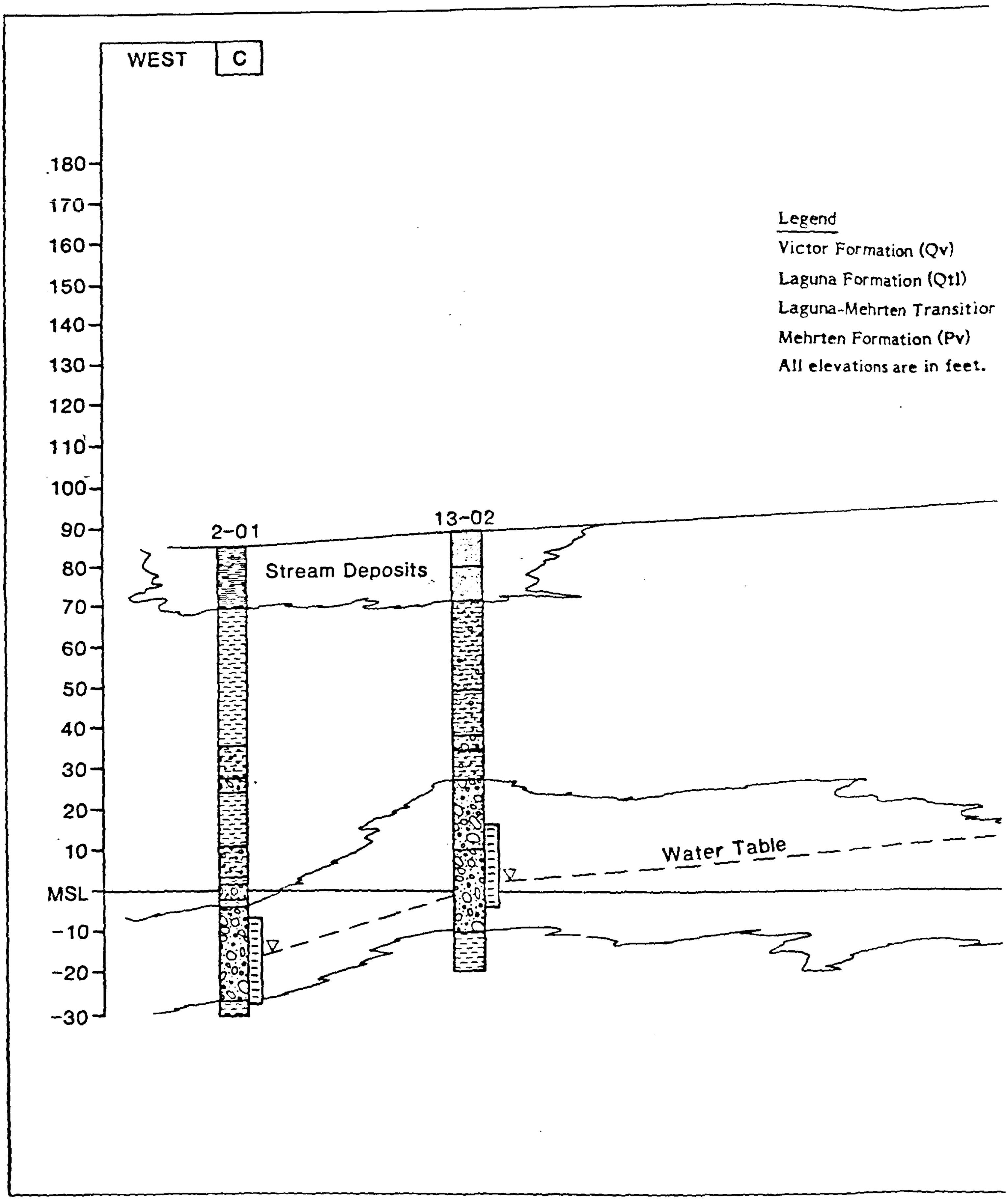


Figure IV-3

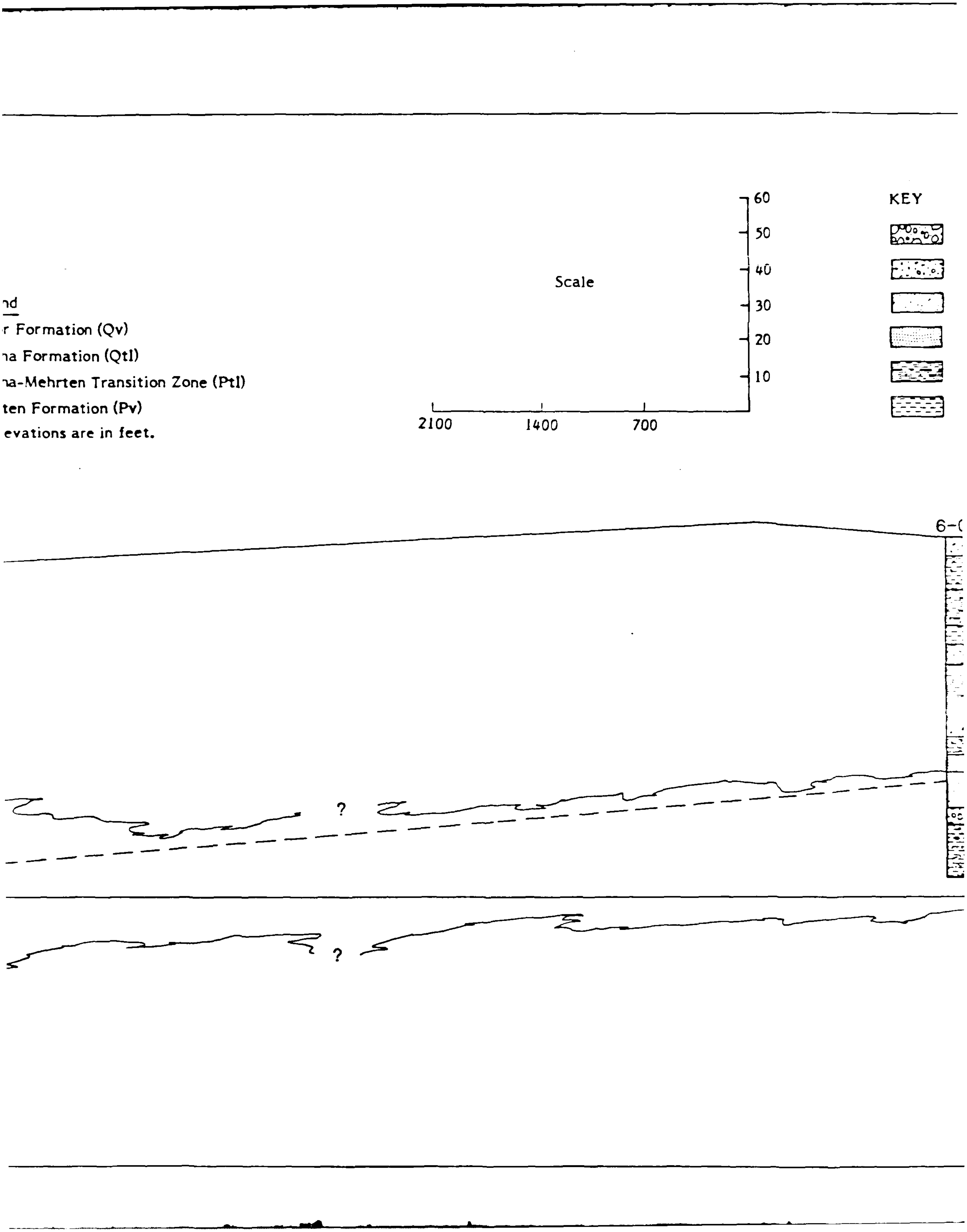
Geologic Cross Section B-B'

Beale Air Force Base

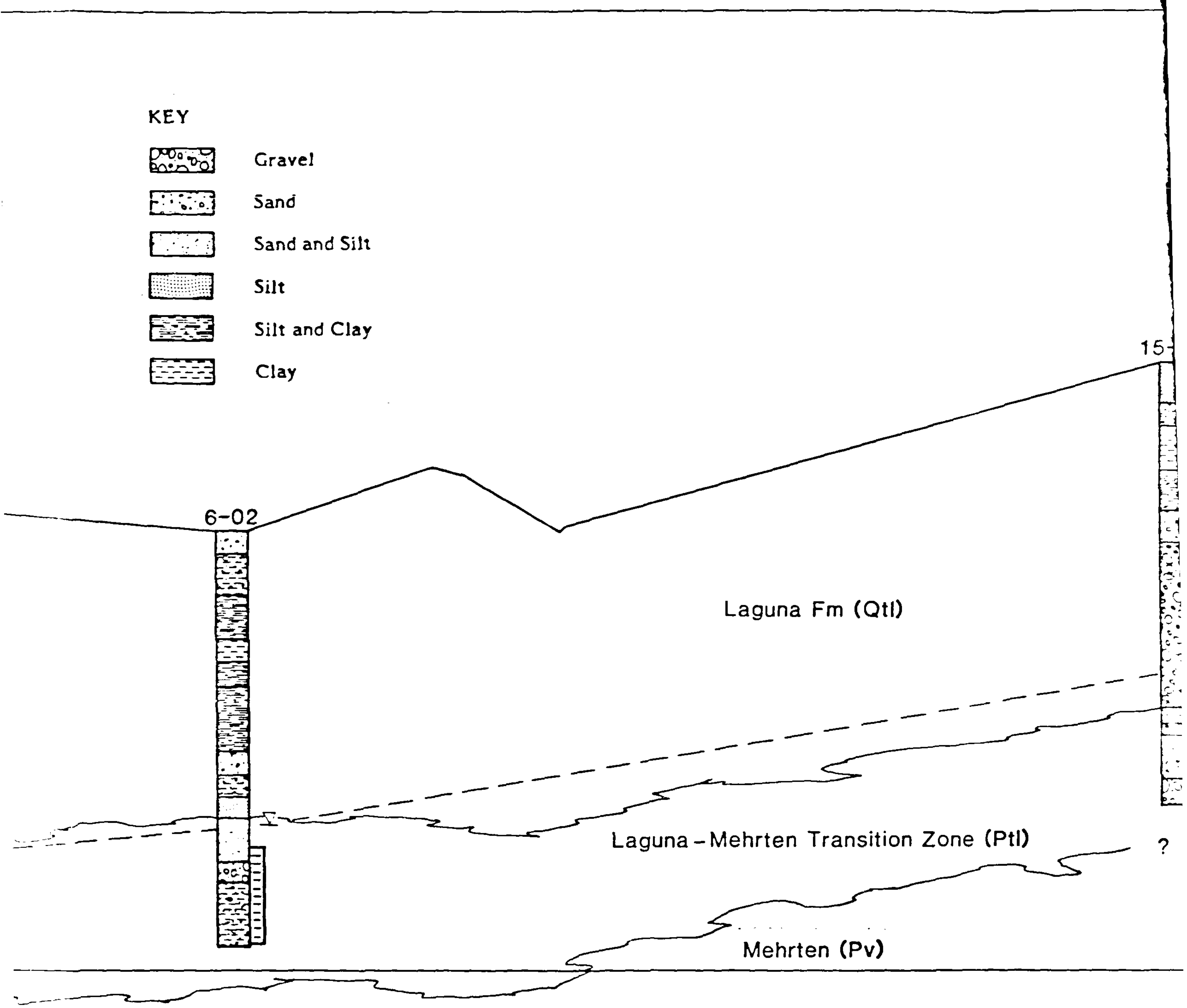
AeroVironment Inc.



WEST
C
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
MSL
-10
-20
-30
2-01
13-02
Stream Deposits
Water Table
Legend
Victor Formation (Qv)
Laguna Formation (Qtl)
Laguna-Mehrten Transitior
Mehrten Formation (Pv)
All elevations are in feet.



KEY
Scale
60
50
40
30
20
10
2100
1400
700
nd
r Formation (Qv)
na Formation (Qtl)
na-Mehrten Transition Zone (Ptl)
ten Formation (Pv)
evations are in feet.
6-(
?
?


KEY
Gravel
Sand
Sand and Silt
Silt
Silt and Clay
Clay
6-02
15-
Laguna Fm (Qtl)
Laguna-Mehrten Transition Zone (Ptl)
?
Mehrten (Pv)

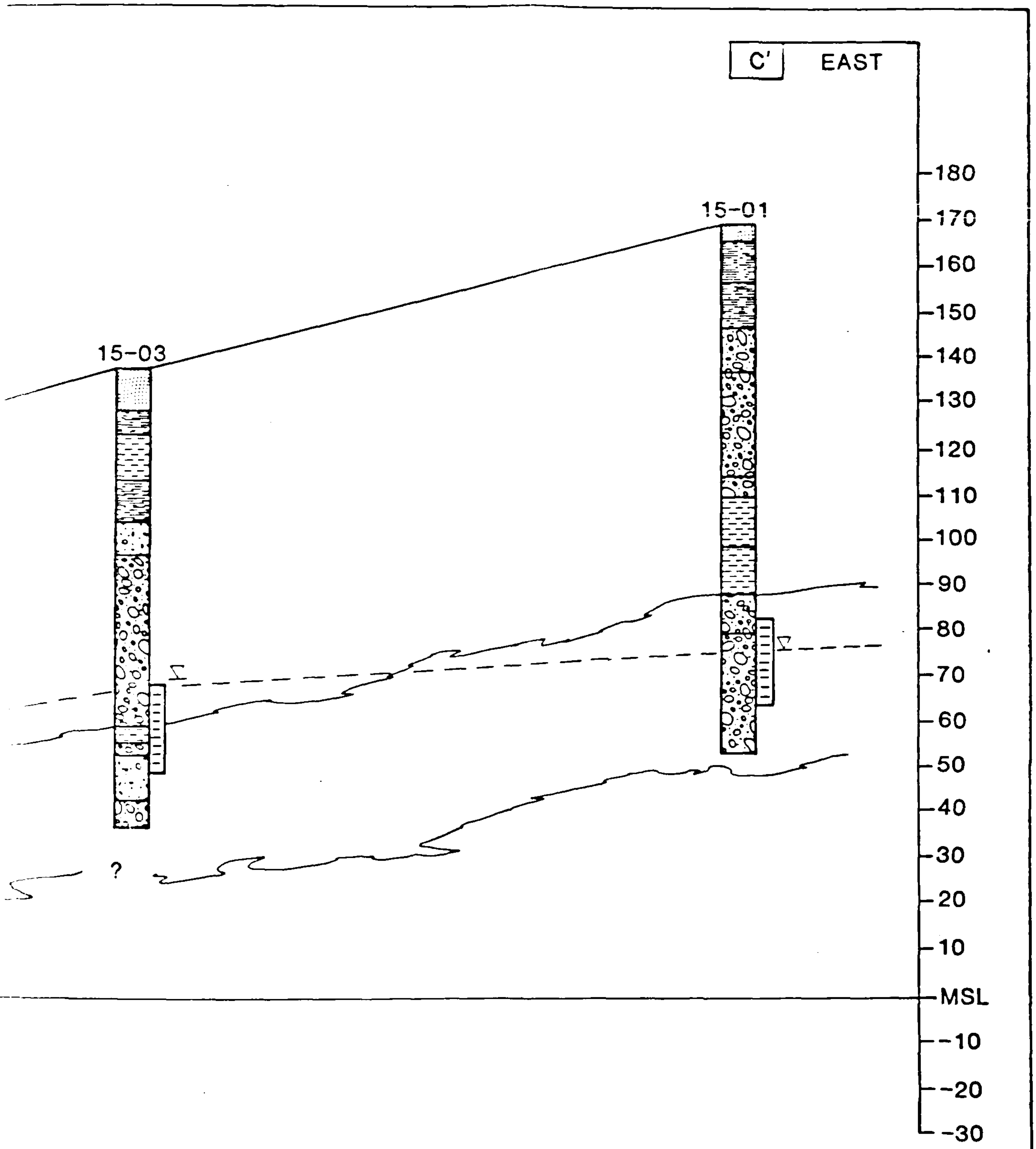


Figure IV-4
Geologic Cross Section C-C'
Beale Air Force Base

AeroVironment Inc.

to sand with occasional cementation; gravel is generally in small stringers. An exception to the general rule is found near Site 15 (Landfill No. 3), which is near the eastern edge of the Laguna Formation. There, a thick gravel sequence known as the Arroyo Seco Gravels is included near the top of the Laguna. It consists of pebble- to cobble-size gravel with medium to very coarse sand. Occasional zones of cemented sands are found with the gravels.

Beneath the Laguna Formation lies the Laguna-Mehrten Transition Zone (Ptm), which has been mapped as either the top of the Mehrten or the bottom of the Laguna. It is a very coarse sand to gravel section with little or no silt and may be up to 40 feet thick. The transition zone was found in all of our well borings in the south of the base and in many of the flightline area wells. It was not found in any of the fire training area (Site 3) wells or at the J-57 Test Cell (Site 8); at these sites the Laguna Formation sits directly on the Mehrten.

The Mehrten Formation (Pv), lies below either the transition zone or the Laguna Formation, depending on the site. It is characterized by dark volcanic angular gravels, sands, mudflows and clays. The uppermost unit is a clay derived from weathered volcanic fragments. Remnant structures are preserved in the clay, giving it a mottled appearance. This clay unit is at least 40 feet thick, as was determined by sinking Well 03-01 that far into the clay before drilling was ended. The Mehrten Formation is highly permeable in some areas and yields large quantities of water to deep wells.

2. Groundwater

During the field program, 20 groundwater monitoring wells were installed. These were screened in the first water-bearing zone encountered (water table aquifer). The water table is generally found in either the Laguna Formation or in the Laguna-Mehrten transition zone on base, but the Victor Formation is also an important source of water in areas to the west of the base. After all the wells were completed, measuring points were surveyed to an accuracy of ±0.01 feet above mean sea level (MSL) by a California-licensed land surveyor. Lateral location was determined to an accuracy of ±1 foot. This information is presented in Table IV-1.

TABLE IV-1

Monitoring Well Locations

Drill Hole No.	Northing[1]	Easting[1]	Elevation[2] (ft)
Well 1-01	537,688.16	2,158,368.49	93.77
Well 2-01	517,646.23	2,161,485.47	87.88
Well 3-01	532,840.06	2,165,054.20	114.17
Well 3-02	532,487.77	2,165,062.33	108.45
Well 3-03	532,240.78	2,164,323.61	102.35
Well 3-04	532,467.15	2,164,281.03	106.65
Well 3-05	532,750.86	2,164,081.18	105.48
Well 4-01	540,292.25	2,161,867.39	118.25
Well 5-01	538,957.53	2,160,656.55	108.38
Well 6-01	521,695.53	2,171,141.19	100.63
Well 6-02	520,912.76	2,170,819.96	99.46
Well 8-01	543,459.38	2,160,629.44	155.09
Well 10-01	539,825.67	2,164,943.09	140.46
Well 11-01	541,639.68	2,161,288.20	124.89
Well 13-01	518,694.57	2,162,556.24	91.46
Well 13-02	518,446.25	2,162,728.65	95.43
Well 15-01	522,541.45	2,179,046.90	170.49
Well 15-02	522,545.13	2,175,855.49	135.70
Well 15-03	521,816.66	2,175,839.30	136.30
Well 15-04	521,265.07	2,176,114.02	141.07

(1) Based on California state plane coordinate system, Zone 2. Northing and Easting values give the position of a point in this system.

(2) Elevation of measuring point in feet above mean sea level.

Note: These wells are tied to Beale AFB existing control point(s) provided by base Civil Engineering, without any attempt to verify the control point. Surveying was performed by Mr. William Donavan of Silver City, Nevada, California RLS No. 5384.

Once the measuring points were established, accurate static water levels were measured in April 1986 and a groundwater contour map of the water table was generated (see Table IV-2 and Figure IV-5). Flow in the water table aquifer is controlled regionally by a large pumping depression south and west of the base. Locally, it is affected by the change in topography where hilly upland areas change into floodplains, as is found in the fire training area and where Hutchinson Creek drains the foothills. Water levels were measured again in October 1986 to provide data on groundwater levels and flow near the end of the dry season. The October water levels have been plotted as a contour map and are shown in Figure IV-6.

Measuring points for the wells were defined as the top of the protective outside casing, at the hinge for above ground completions, and the metal rim of the christie box for flush-mount completions. Figure III-1 shows these measuring points.

3. Geophysical Data

Site 13 (Landfill No. 1) was investigated using magnetometer and ground-penetrating-radar techniques. This survey showed that at one point the fill material extended to within 50 feet to Hutchinson Creek, which was closer than expected. It also identified areas where metallic objects are buried; however, none of these are considered significant because of typical landfill metal content.

4. Soil Sampling Results

The results of the analyses performed on soil samples indicate that soil contamination has occurred at several sites. This section presents results from the analysis of soil boring, bottom sediment, hand-auger and grab samples. Water results are discussed separately in the next section.

In determining the significance of the analytical results, background levels were established for each analytical parameter. These levels were used for comparison to differentiate between actual evidence of

TABLE IV-2. Water level information
(All data presented in feet)

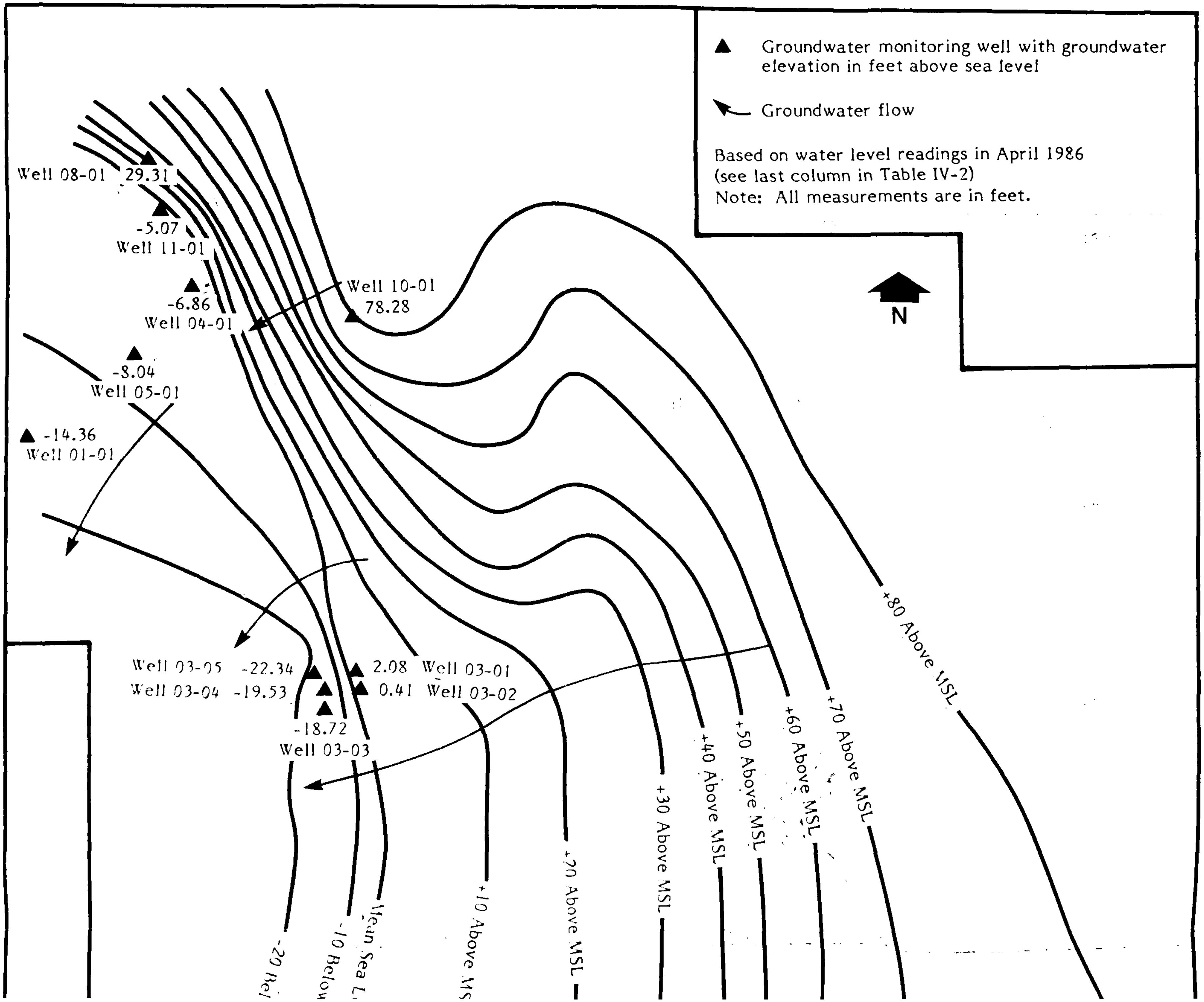
Site	Well No.	Measuring Point Elevation (1)	April 1986		October 1986	
			Depth to Static Water (2)	Water Level Elevation (3)	Depth to Static Water (2)	Water Level Elevation (3)
1 West Drainage	1-01	93.77	108.13	-14.36	107.13	-13.36
2 Photo Waste	2-01	87.88	102.38	-14.50	101.73	-13.85
Radian Wells	R-1	93.95	87.70	6.25	---	--
	R-2	93.05	87.00	6.05	85.00	8.05
	R-3	96.45	86.40	10.05	84.57	11.88
	R-4	95.32	88.06	7.26	85.97	9.35
3 Fire Training Area	3-01	114.17	112.09	2.08	112.47	1.70
	3-02	108.45	108.04	0.41	108.01	0.44
	3-03	102.35	121.07	-18.72	122.83	-20.48
	3-04	106.65	126.18	-19.53	126.57	-19.92
	3-05	105.48	127.82	-22.34	129.25	-23.77
4 Battery Shop	4-01	118.25	125.11	-6.86	122.89	-4.64
5 SR-71 Shelters	5-01	108.38	116.42	-8.04	114.25	-5.87
6 Landfill No. 2	6-01	100.63	63.55	37.08	64.54	36.09
	6-02	99.46	66.02	33.44	67.88	31.58
8 J-57 Test Cell	8-01	155.09	125.78	29.31	124.45	30.64
10 J-58 Test Cell	10-01	140.46	62.18	78.28	61.23	79.23
11 AGE Maintenance	11-01	124.89	129.96	-5.07	127.78	-2.89
13 Landfill No. 1	13-01	91.46	82.20	9.26	81.15	10.31
	13-02	90.43	87.43	3.00	85.42	5.01
15 Landfill No. 3	15-01	170.49	95.00	75.49	94.65	75.84
	15-02	135.70	67.80	67.90	68.00	67.70
	15-03	136.30	66.06	70.24	66.91	69.39
	15-04	141.07	71.95	69.12	71.04	70.03

(1) Measuring point for flush mount wells was ground surface, and for above-ground completions was the top of the outer casing (see Figure III-1).

(2) Depth from measuring point to static water level.

(3) Elevation of water as feet above mean sea level.

86-51


Groundwater monitoring well with groundwater elevation in feet above sea level
Groundwater flow
Based on water level readings in April 1986
(see last column in Table IV-2)
Note: All measurements are in feet.
N
Well 08-01 29.31
-5.07
Well 11-01
-6.86
Well 04-01
Well 10-01
78.28
-8.04
Well 05-01
-14.36
Well 01-01
Well 03-05 -22.34
Well 03-04 -19.53
2.08 Well 03-01
0.41 Well 03-02
-18.72
Well 03-03
+80 Above MSL
+70 Above MSL
+60 Above MSL
+50 Above MSL
+40 Above MSL
+30 Above MSL
+20 Above MSL
+10 Above MS
Mean Sea L
-10 Below
-20 Bel

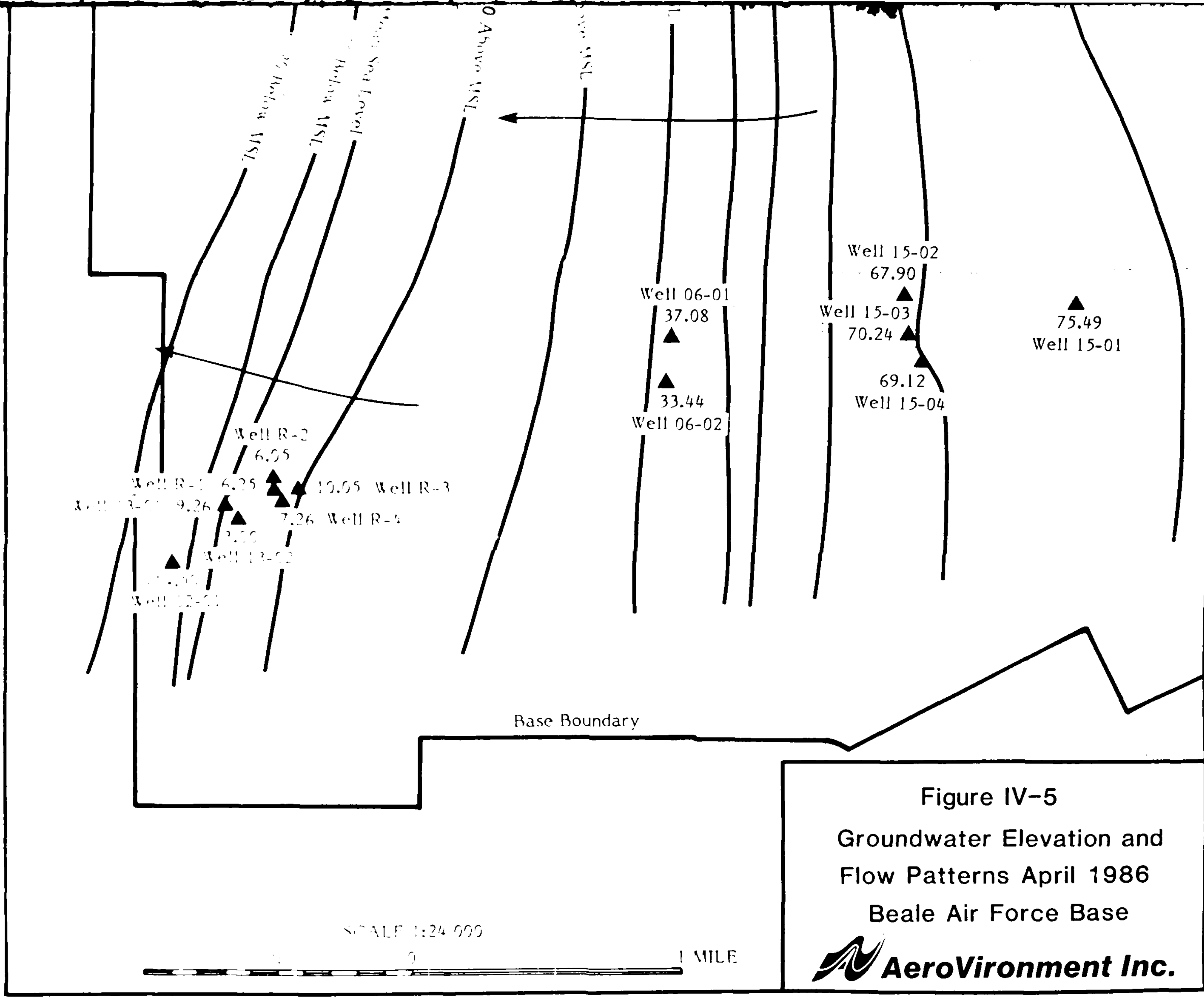
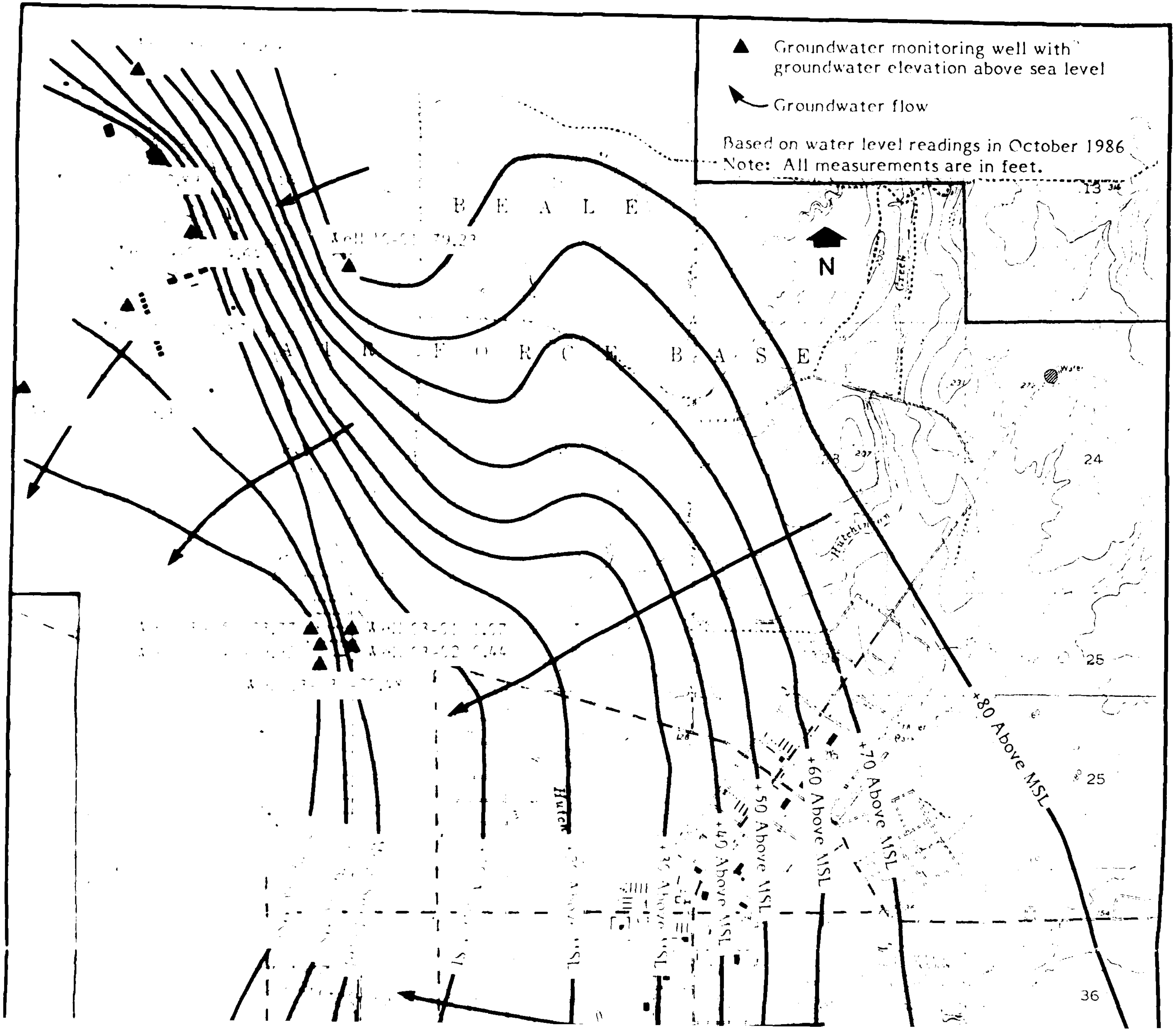


Figure IV-5

Groundwater Elevation and Flow Patterns April 1986 Beale Air Force Base

AeroVironment Inc.


Groundwater monitoring well with groundwater elevation above sea level
Groundwater flow
Based on water level readings in October 1986
Note: All measurements are in feet.
N
BEALE
AIR FORCE BASE
+80 Above MSL
+70 Above MSL
+60 Above MSL
+50 Above MSL
+40 Above MSL
24
25
25
36

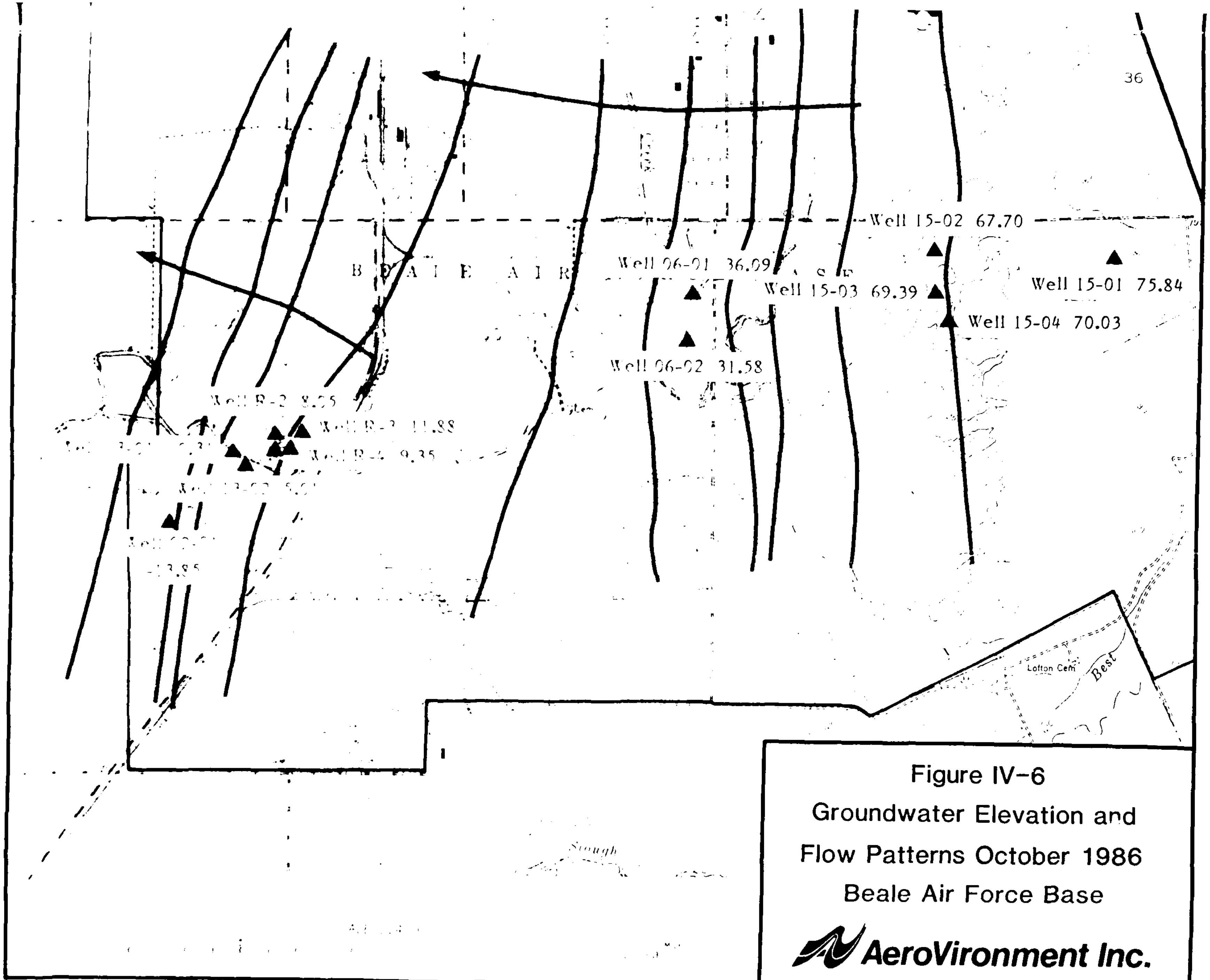


Figure IV-6
Groundwater Elevation and
Flow Patterns October 1986
Beale Air Force Base

AeroVironment Inc.

contamination and insignificant values. Background levels were established based upon one or more of the following factors:

- Method detection limits (MDL) and levels of quantification (LOQ).

- Laboratory background levels observed in method blank samples.

- A memo dated February 1985 from T. Thomas of OEHL at Brooks AFB listing background levels of oil and grease, TOC, phenolics, lead, VOCs, vinyl chloride, total organic halogens (TOX), and organochlorine pesticides for Air Force installations, based upon OEHL's experience.

- Naturally occurring background levels which were observed normally distributed throughout the entire sample set.

The established background levels are listed below by parameter:

- Oil & Grease (O&G) - Levels greater than the 100 µg/g method detection limit (MDL) were considered above background.

- Lead - Levels greater than 40 µg/g were considered above background.

- Other Metals - Levels of arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), lead (Pb), mercury (Hg), selenium (Se), and silver (Ag) were evaluated in accordance with the methods of the California Regional Water Quality Control Board, Central Valley Region, as expressed in "Waste Classification and Cleanup Level Determination" (November 12, 1985), pg. 69.

- Volatile Organic Compounds (VOC) - Methylene chloride, a common laboratory contaminant, was detected in almost all soil samples analyzed for EPA 601 compounds. Ethylbenzene was a

periodic laboratory contaminant in the EPA 602 analysis. These contaminants were identified by their presence in method blank samples. Therefore, elevated levels of these two chemicals were not considered significant (ethylbenzene, a gasoline component, was considered significant when reported in conjunction with elevated levels of other volatile aromatics). Other volatile organics detected at levels greater than 1 μg/g were considered above background.

- Phenolics - Levels greater than 25 μg/g were considered above background.

- Pesticides - Levels greater than 1 μg/g were considered above background.

The significance of findings is also impacted by regulatory guidelines for "acceptable" levels of contamination. For domestic water supplies, including groundwater, the California Department of Health Services (DOHS) establishes action levels for specific organic and inorganic compounds of concern. Drinking water standards are also established at the federal level by the Environmental Protection Agency (EPA) as recommended maximum contaminant levels (RMCLs). The RMCLs were adopted for use in California by DOHS.

There are fewer clear-cut standards, however, for soil contamination. The DOHS regulations for classifying wastes as "hazardous" and "restricted hazardous" apply only to heavily contaminated soils which would meet hazard criteria in four areas: toxicity, ignitability, reactivity and corrosivity. The toxicity criteria establish soluble threshold limit values (STLCs) and total threshold limit values (TTLCs) for hazardous wastes which are presented in Table IV-3. In further discussions, whenever possible, soil sample results from Beale will be compared with STLCs and TTLCs.

Levels of contamination that do not meet the DOHS definition of a hazardous waste, but that still pose a potential threat to water quality define a

TABLE IV-3. Soil comparison criteria.

STLC and TTLC Standards for
Inorganic Constituents of Hazardous Waste

SUBSTANCE	STLC (MG/L IN EXTRACT)	TTLC (WET WEIGHT MG/KG WASTE)
ANTIMONY AND/OR ANTIMONY COMPOUNDS	15	500
ARSENIC AND/OR ARSENIC COMPOUNDS	5.0	500
ASBESTOS	- -	1.0 %
BARIUM AND/OR BARIUM COMPOUNDS (EXCLUDING BARITE)	100	10,000
BERYLLIUM AND/OR BERYLLIUM COMPOUNDS	0.75	75
CADMIUM AND/OR CADMIUM CONPOUNDS	1.0	100
CHROMIUM (VI) COMPOUNDS	5	500
CHROMIUM AND/OR CHROMIUM (III) COMPOUNDS	560	2,500
COBALT AND/OR COBALT COMPOUNDS	80	8,000
COPPER AND/OR COPPER COMPOUNDS	25	2,500
FLUORIDE SALTS	180	18,000
LEAD AND/OR LEAD COMPOUNDS (INORGANIC)	5.0	1,000
MERCURY AND/OR MERCURY COMPOUNDS	0.2	20
MOLYBDENUM AND/OR MOLYBDENUM COMPOUNDS	350	3,500
NICKEL AND/OR NICKEL COMPOUNDS	20	2,000
SELENIUM AND/OR SELENIUM COMPOUNDS	1.0	100
SILVER AND/OR SILVER COMPOUNDS	5	500
THALLIUM AND/OR THALLIUM COMPOUNDS	7.0	700
VANADIUM AND/OR VANADIUM COMPOUNDS	24	2,400
ZINC AND/OR ZINC COMPOUNDS	250	5,000

TABLE IV-3. (con't)

STLC and TTLC Standards for
Organic Constituents of Hazardous Waste

Substance	STLC (mg/l in extract)	TTLC (wet weight mg/kg waste)
Aldrin	0.14	1.4
Chlordane	0.25	2.5
DDT, DDE, DDD	0.1	1.0
2,4-Dichlorophenoxyacetic acid	10	100
Dieldrin	0.8	8.0
Dioxin (2,3,7,8-TCDD)	0.001	0.01
Endrin	0.02	0.2
Heptachlor	0.47	4.7
Kepone	2.1	21
Lead compounds, organic	- -	13
Lindane	0.4	4.0
Methoxychlor	10	100
Mirex	2.1	21
Pentachlorophenol	1.7	17
Polychlorinated biphenyls (PCBs)	5.0	50
Toxaphene	0.5	5
Trichloroethylene	204	2040
2,4,5-Trichlorophenoxypropionic acid	1.0	10

"designated" waste under regulations established by the Regional Water Quality Control Board System (RWQCB) (CAC Title 23, Subchapter 15). The RWQCB sets clean-up goals on a site-specific basis, taking into account the nature of the contaminant, its degree of attenuation in the soil, and the biological receptors that may be impacted by migration of the contamination into ground or surface waters.

Most of the results of soil analysis at Beale AFB do not fall into the category of hazardous waste, and therefore would require a site-specific evaluation using the RWQCBs designated level criteria to set standards. Analytical parameters such as oil and grease and total phenols have no existing regulatory standards for comparison and will be discussed on the basis of their relative magnitude in the soil.

The site-by-site discussion of the soil sample results below focuses on the interpretation of the data and makes no attempt to describe the magnitude or significance of environmental contamination based upon these data. Groundwater and surface water results are presented in separate sections following the site-by-site discussion of soil results.

Soil results are presented in tables referenced in the following sections. To aid in cross-referencing the data to the laboratory reports from which they are taken, the data tables list the laboratory's sample number [illegible] in the first column, the number of the laboratory report and the page number in Appendix H where it may be found. These report and appendix page [illegible] shown in the upper lefthand corner (report no.) and footnotes (appendix page) [illegible] the table. An introduction to Appendix H explains further how [illegible] information there. That appendix contains analysis dates, [illegible] and detection limits. (Sampling dates are given at the top of [illegible] chapter.)

The three-part [illegible]

No. 2-1-S1 is from Boring 02-01, the first boring at Site No. 2. The third part of the AV sample number shows the type of sample (s = soil boring, h = hand auger, ... bottom sediment, r = grab) and the order in which samples were collected from the hole. Hence, Sample No. 2-1-S1 is the first soil boring sample collected from Boring 02-01. Sampling locations are labeled with the first two parts of the AV sample number on figures presented in the site-by-site discussions. The sample numbering system is discussed further in Appendix D.

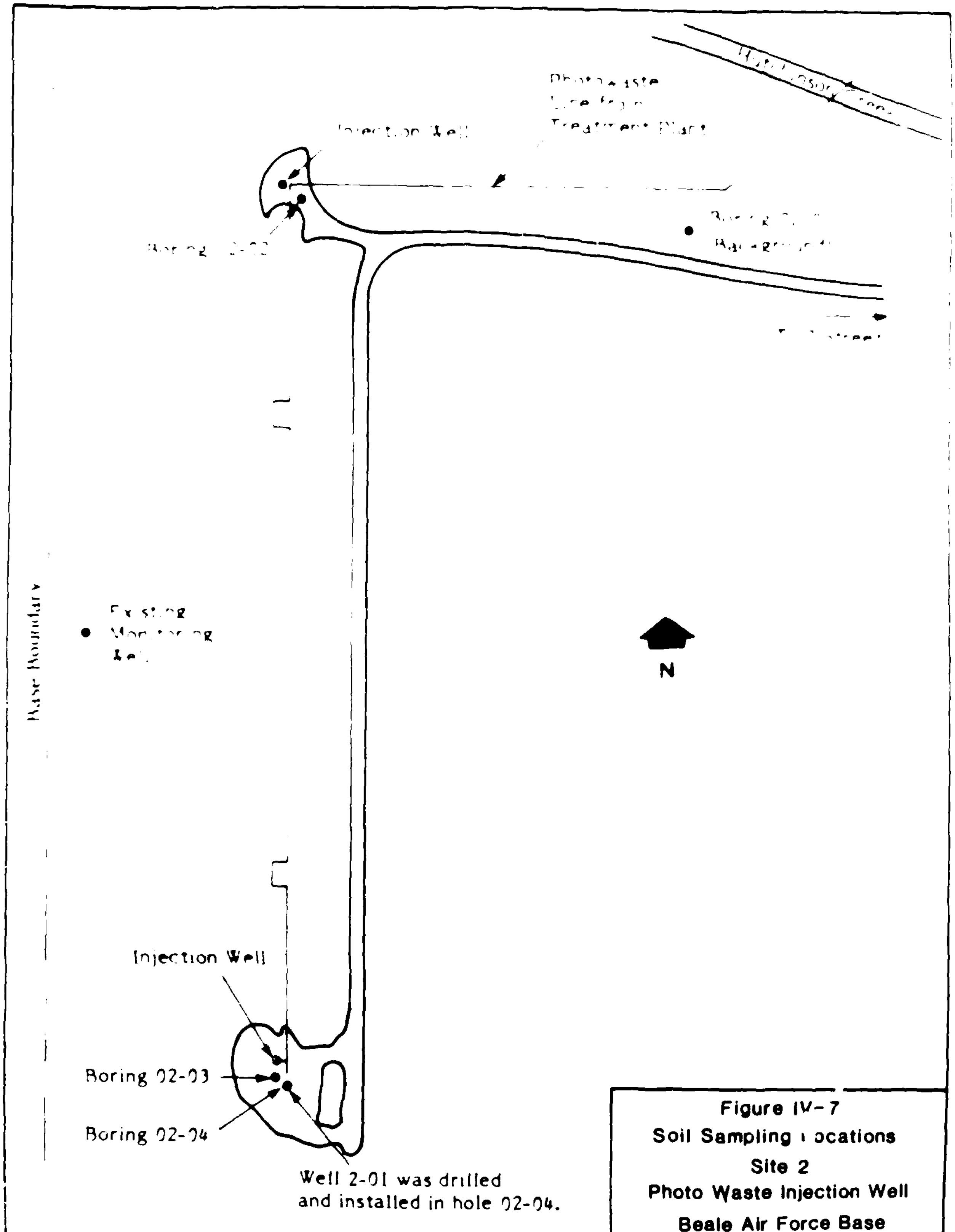
Site 1 -- West Drainage

No soil samples taken.

Site 2 -- Injection Well No. 2

The soil sampling program at Site 2, the photo wastewater ... wells, included four soil borings, each sampled at 1.5-foot, 6.5-foot, ... and 16.5-foot depths (see Figure IV-7). Boring 02-01, the background ... boring, was located along the access road leading into the site and ... from the photo waste line and the injection wellheads. Boring 02-02 ... near the north injection well. Boring 02-03 was located approximately ... south of the blow-down valve at the end of the pipeline. Boring 02-04 was ... approximately five feet southeast of the southern injection wellhead at ... The borings were sited to define the presence and extent of contamination ... caused by the practice of periodically purging the waste lines and ... the injection well filters. Samples from the 1.5-foot and 11.5-foot depths ... for volatile organics, O&G, and base/neutrals and acid extractables ... Table IV-4 gives the results.

Contamination in the form of elevated O&G and pentachloro- ... was found in Boring 02-04 at a depth of 16.5 feet, but no evidence ... was found in any of the shallower samples. Pentachlorophenol ... the photo wastewater as a bactericide until February 1986. Since ... was the only hole at Site 2 from which a 16.5-foot sample was



Scale: 1" = 120'
Note: See Figure I-3 for general location of this site.

Figure IV-7
Soil Sampling Locations
Site 2
Photo Waste Injection Well
Beale Air Force Base

AeroVironment Inc.

TABLE IV-4.

Soil Sampling Results

Site 2 - Injection Well No. 2

SITE 2 - INJECTION WELL NO. 2 Sampled 11/12/85 for 8010 8020 [illegible]
Acurex Report # 8511-033 UNITS UG/G

			8010							
ACUREX #	AV SAMPLE#	DEPTH (FT)	Methylene chloride	Chloroform	1,1,1 TCA	Tetrachloroethene	Benzene	Toluene	[illegible]	[illegible]
904253	2-1-S1	1.5	0.002	0.0003	0.0001				[illegible]	
904256	2-1-S3	11.5	0.002	0.0004			[illegible]	[illegible]	[illegible]	
904258	2-2-S1	1.5	0.003	0.0004			[illegible]	[illegible]	[illegible]	
904260	2-2-S3	11.5	0.002	0.0004	0.0003			[illegible]	[illegible]	
904262	2-3-S1	1.5	0.002	0.0003				[illegible]	[illegible]	
904264	2-3-S3	11.5	0.002	0.0004			[illegible]	[illegible]	[illegible]	[illegible]
904266	2-4-S1	1.5	0.003	0.0004	0.00004		[illegible]	[illegible]	[illegible]	[illegible]
904268	2-4-S3	11.5	0.002	0.0004			[illegible]	[illegible]	[illegible]	
	2-4-S5	16.5	0.002	0.0004		0.0001		[illegible]	[illegible]	[illegible]

Note: Only those results reported at concentrations above detection are presented.

Site 2 soil boring ("S") sample analytical data are presented in Appendix H, Laboratory Report No. 8511-033, starting on Page H-67, except for sample 2-4-S5, which is in Report 8511-035, starting on Page H-91.

Data are reported by Acurex sample number.

The TTLC for pentachlorophenol [illegible]

[illegible] propene is relatively mobile in the soil, contamination may [illegible] at the other sampling locations below 11.5 feet.

No soil samples were collected from the well drilling operations because the cuttings for air rotary drilling were totally aerated and mixed. Volatile organic analyses of these soils would have been inappropriate.

Site 3 - Fire Protection Training Areas 1 & 2 (FPTA Nos. 1 & 2)

A total of eight soil borings were drilled at Site 3 (see Figure IV-8). Boring 03-01, a background reference boring, was located north of FPTA No. 2 in an area free of contamination, based on records showing that no fire training activity occurred there. Boring 03-02 was located downgradient of the two underground storage tanks. Borings 03-03 and 03-04, located east of FPTA No. 2, were sited in an area suspected to be the old FPTA No. 1, based upon air photos included in the Phase I report. Boring 03-05 was located as close as possible to the underground storage tanks to detect any tank leakage. Borings 03-06, 07 and 08 were located inside the airplane mock-up area at FPTA No. 2.

Other soil sampling at Site 3 included six hand-auger samples from three locations along the 27th Street drainage ditch, which receives runoff from the entire FPTA area, and two surface sediment samples from the runoff pond located south of FPTA No. 2. Table IV-5 shows the soil sampling results for this site.

Soil Boring 03-02 was located approximately 50 feet west of the underground storage tanks. Oil and grease (O&G) and petroleum hydrocarbon (Pet HC) levels were above background in the 1.5-foot sample from this boring. The original hole was terminated at 4 feet due to an obstruction and moved 6 feet to the west. Strong hydrocarbon odors were noticed while drilling the original hole, but were not observed for the second boring, which showed no evidence of contamination to a final depth of 11.5 feet. Because the original hole was located closer to the underground tanks than the second hole, the decision was made to drill a third hole, Boring 03-05, close to the tanks to check suspected leakage.

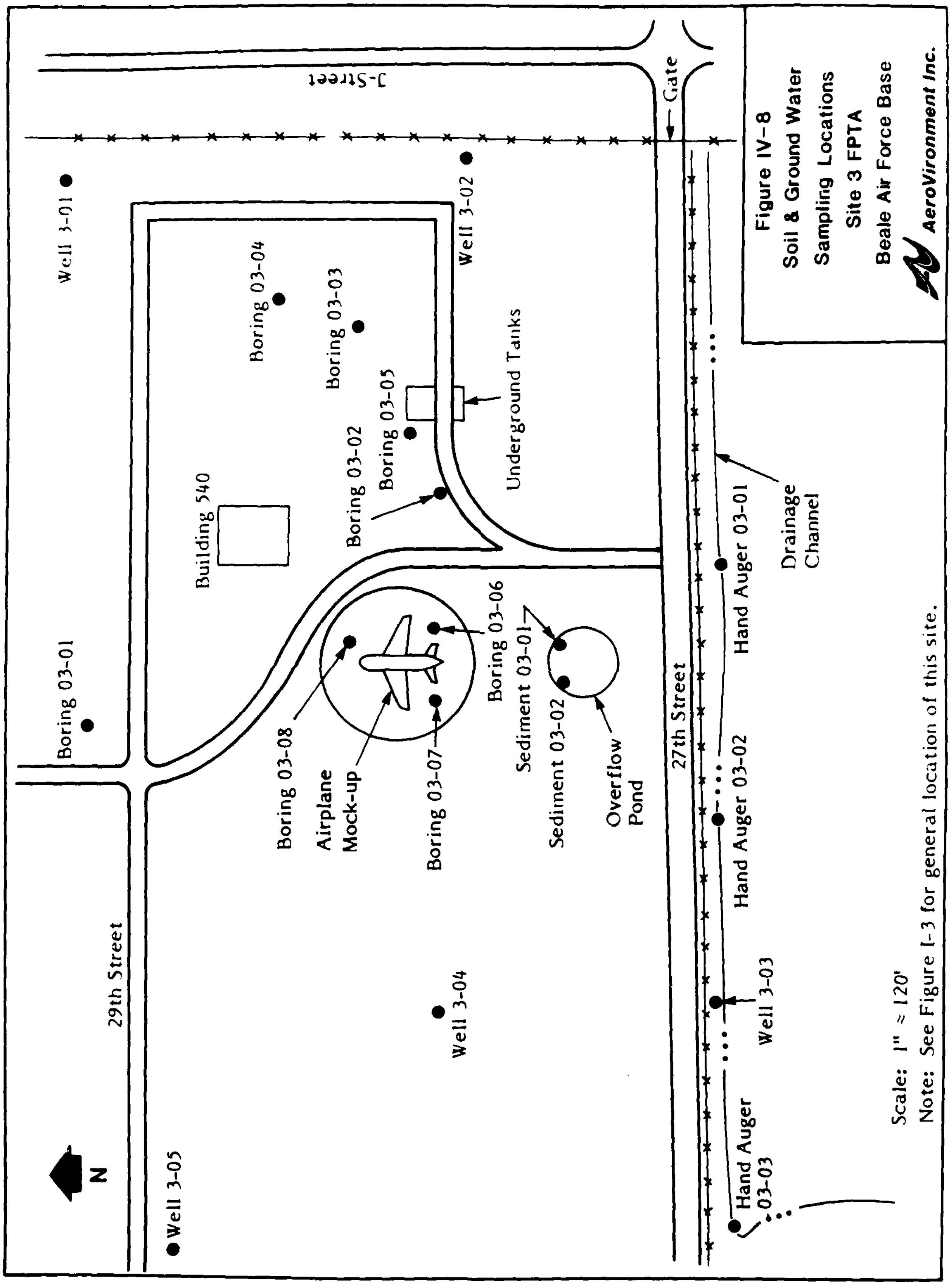


Figure IV-8
Soil & Ground Water
Sampling Locations
Site 3 FPTA
Beale Air Force Base
AeroVironment Inc.
J-Street
Gate
29th Street
27th Street
Well 3-01
Well 3-02
Well 3-03
Well 3-04
Well 3-05
Boring 03-01
Boring 03-02
Boring 03-03
Boring 03-04
Boring 03-05
Boring 03-06
Boring 03-07
Boring 03-08
Building 540
Underground Tanks
Airplane
Mock-up
Sediment 03-01
Sediment 03-02
Overflow
Pond
Hand Auger 03-01
Hand Auger 03-02
Hand Auger
03-03
Drainage
Channel
N
Scale: 1" ≈ 120'
Note: See Figure I-3 for general location of this site.

TABLE IV-5.

Soil Sampling Results

Site 3 - Fire Protection Training Area

SITE 3 - FIRE PROTECTION TRAINING AREA

SOIL BORING SAMPLES
Acurex Report # 8511-003

Sampled 10/31/85 for Oil & Grease, Petroleum & Hydrocarbons, Phenols, Lead and 8010/8020
UNITS-UG/G

ACUREX #	AV SAMPLE#	DEPTH (FT)	O&G	PET HC	PHENOLS	Pb
904231	3-1-S1	1.5	<100	<100	1	8
904232	3-1-S2	5.5	<100	<100	<1	16
904197	3-1-S3	11.5	<100	<100	<1	11
904199	3-2-S1	1.5	1400	1400	<1	13
904200	3-2-S2	6.5	<100	<100	<1	10
904201	3-2-S3	11	<100	<100	<1	8
904202	3-3-S1	1.5	<100	<100	<1	15
904203	3-3-S2	6.5	<100	<100	<1	9
904204	3-3-S3	11.5	<100	<100	<1	8
904206	3-4-S1	1.5	<100	<100	<1	17
904207	3-4-S2	6.5	<100	<100	<1	9
904208	3-4-S3	11.5	<100	<100	<1	7
904210	3-5-S2	6.5	600	600	<1	11
904211	3-5-S3	11.5	800	900	<1	14
904212	3-5-S4	16.5	<100	<100	<1	9
904213	3-6-S1	1.5	600	700	1	15
904214	3-6-S2	6.5	<100	<100	<1	9
904236	3-6-S3	11.5	4900	4600	<1	14
904234	3-6-S4	16.5	<100	<100	1	8
904235	3-7-S1	1.5	1000	1000	1	22
904237	3-7-S2	6.5	<100	<100	<1	11
904238	3-7-S3	11.5	<100	<100	<1	9
904239	3-7-S4	16.5	<100	<100	<1	9
904240	3-8-S1	1.5	900	900	2	30
904241	3-8-S2	6.5	<100	<100	<1	8
904242	3-8-S3	11.5	2800	2400	<1	12

ACUREX #	8010 Methylene chloride	trans-1,2-DCE	Chloroform	1,1,1 TCA	TCE	Tetrachloroethene	Dichlorobenzenes	1,1,2-Trichloroethane	1,1 DCE	Other
904231	0.002		0.0006		0.001					
904232	0.0003		0.0004		0.0001					
904197	0.005		0.0008			0.0003	0.0006	0.0001		
904199	0.011	0.0001	0.009	0.0001	0.004	0.001		0.0001		Bromodichloromethane 0.0004
904200	0.007		0.0002		0.0002					
904201	0.003		0.0001	0.00004	0.0003					
904202	0.003		0.0001							
904203	0.0009		0.0008	0.0002	0.0002	0.0003				Chloromethane 0.0008
904204	0.0009		0.0005	0.0002						Chloromethane 0.0001
904206	0.0008		0.001	0.0001						
904207	0.003		0.001	0.0001	0.0003		0.0007			
904208	0.0005		0.0006	0.0001						
904210	0.01		0.003	0.0005	0.002	0.011	0.01			
904211	0.0006	0.0002	0.0007		0.0001	0.004	0.004			
904212	0.0009		0.0008					0.0004		
904213	0.006	0.0001	0.0005	0.00003	0.0003					
904214	0.0004	0.0002	0.0005		0.0002		0.0003			
904236	0.005	0.014	0.011	0.0001	0.025	0.002	0.034			
904234			0.0004							
904235	3.7	1.1	0.67	0.007	2.5	0.026	0.1		0.003	Bromodichloromethane 0.005
904237	0.004	0.003	0.001		0.021	0.0001	0.0008	0.0002		
904238	0.002	0.0001	0.0006		0.0003			0.0001		
904239	0.002		0.0004		0.0002					
904240	0.003	0.002	0.0007	0.0001	0.0002					
904241	0.004	0.001	0.0005		0.0002					
904242	0.004	0.077	0.002	0.00003	0.14	0.002	0.003			

ACUREX #	8020 Benzene	Toluene	Ethyl Benzene	Chlorobenzene	Xylenes	Dichlorobenzenes
904231		[illegible]	[illegible]			
904232			[illegible]			
904197		[illegible]	[illegible]			
904199					[illegible]	[illegible]
904200			[illegible]			
904201		[illegible]	[illegible]			
904202		[illegible]	[illegible]			
904203		[illegible]	[illegible]			
904204			[illegible]			
904206		[illegible]	[illegible]			
904207			[illegible]			
904208			[illegible]		[illegible]	
904210					[illegible]	
904211		[illegible]	[illegible]		[illegible]	
904212		[illegible]	[illegible]			
904213		[illegible]	[illegible]			[illegible]
904214	[illegible]	[illegible]	[illegible]	[illegible]		
904236	[illegible]	[illegible]			[illegible]	[illegible]
904234	[illegible]	[illegible]	[illegible]	[illegible]		
904235		[illegible]	[illegible]		[illegible]	
904237	[illegible]	[illegible]	[illegible]			
904238		[illegible]	[illegible]			
904239		[illegible]	[illegible]			
904240		[illegible]	[illegible]		[illegible]	
904241		[illegible]	[illegible]		[illegible]	
904242			[illegible]		[illegible]	

Note: Only those results reported at concentrations above detection are presented.

Site 3 soil boring ("S") sample analytical data are presented in Appendix H, Laboratory Report No. 8511-003, starting on page H-40.

Data are reported by Acurex sample number.

Compound	TTLC (µg/g)
Pb	1000
TCE	2040

TABLE IV-5. (Con't.)

SITE 3- FIRE PROTECTION TRAINING AREA

BOTTOM SEDIMENT SAMPLES
Acurex Report # 8511 052

Sampled 11 [illegible]
UNITS-UG/G

ACUREX #	SAMPLE#	DEPTH (FT)	O&G	PET HC	PHENOLS	Pb	Methylene Chloride	[illegible]	[illegible]
810827	3-2-B1	0.5	1400	1100	<1	4[illegible]	0.003		[illegible]
810826	3-1-B1	0.5	200	100	<1	2[illegible]	0.003	[illegible]	[illegible]

HAND AUGER SOIL SAMPLES
Acurex Report # 8511 048

Sampled 11/2[illegible] 85 [illegible]
UNITS UG/G

ACUREX #	SAMPLE#	DEPTH (FT)	O&G	PET HC	PHENOLS	Pb	Methylene Chloride	[illegible]	[illegible]
810795	3-1-H1	0.5	<100	<100	<1	13	[illegible]	[illegible]	[illegible]
810796	3-1-H2	1.5	<100	<100	<1	12	[illegible]	[illegible]	[illegible]
810797	3-2-H1	0.5	<100	<100	<1	14	[illegible]	[illegible]	[illegible]
810798	3-2-H2	1.5	<100	<100	<1	11	[illegible]	[illegible]	[illegible]
810799	3-3-H2	0.5	<100	<100	<1	2[illegible]	[illegible]	[illegible]	[illegible]
810800	3-3-H2	1.5	<100	<100	<1	25	[illegible]	[illegible]	[illegible]

Note: Only those results reported at concentrations above detection are presented.

Site 3 bottom sediment ("B") sample analytical data are presented in Appendix H, Laboratory Report No. 8511-052, beginning on Page H-169.

Site 3 hand auger ("H") soil samples analytical data are presented in Appendix H, Laboratory Report No. 8511-048, beginning on Page H-136.

Data are reported by Acurex sample number.

Compound	TTLC (μg/g)
Pb	[illegible]
TCE	[illegible]

[illegible] feet [illegible] the existing [illegible] of (TPTA No. 2), in samples from Borings 03-06, 07 and 08 [illegible]. Organic contamination, indicated by elevated levels of O&G (up to [illegible] µg/g), petroleum hydrocarbons (up to [illegible] µg/g) and volatile aromatics (toluene, xylenes, ethylbenzene and dichlorobenzenes), was found in all three 1.5 foot samples. The contamination diminished in the 6.5-foot samples, but was significantly elevated in two of the three samples at 11.5 feet (up to [illegible] µg/g O&G). Samples taken at a final depth of 16.5 feet were mostly free of contamination (slightly elevated concentrations of toluene and ethylbenzene were found at 16.5 feet in Boring 03-07).

Chlorinated volatile organic compounds were detected at significant levels in the 1.5-foot sample from Boring 03-07. This is the only occurrence of this class of contaminants at Site 3. Methylene chloride was reported at 3.7 µg/g in the same sample, but is thought to be laboratory background error, magnified by a dilution factor of 100. Laboratory-induced methylene chloride was reported for most of the soil samples collected as part of this field program, but at much lower levels (typically 0.003 µg/l) than those reported for the 1.5-foot sample from Boring 7. Trichloroethene (TCE) and trans-1,2-dichloroethene (DCE) were also found in this sample at 2.5 and 1.1 µg/g. This sample also shows the only elevated level of lead found in the soil at Site 3. Lead

[illegible] above background at [illegible] ug/g and copper [illegible] background level [illegible].

Hand-auger samples were collected from three locations along the [illegible] that receives runoff from the entire FPTA area. No evidence of [illegible] was found in any of the samples taken from 5- to .5-foot and [illegible] foot depths.

Sediment samples taken from the perimeter of the small overflow pond south of FPTA No. 2 indicate hydrocarbon contamination. Samples were collected approximately 3[illegible] feet apart, from 5- to .5-foot depths, at the north side of the pond (near the influent pipe). O&G and petroleum hydrocarbons levels were high in one sample and slightly elevated in the other. Lead was detected above background in both samples (27 and 47 ug/g), but not at significant levels.

Site 4 -- Battery Shop Dry Well

Soil samples were originally planned at the Battery Shop Dry Well but were not collected. Soil samples from the well drilling would not have been appropriate for VOC testing so no attempt was made to collect them. The planned soil boring was not completed for the following reasons:

- The boring was attempted once at a secondary location, but soil conditions under the concrete pad were found to be very hard. Not only was it difficult to advance the augers, but soil collection with the split spoon would have been nearly impossible. The drilling was stopped at 5 feet.

- The dry well was at least 20 feet deep. Collecting soil samples 30 feet away, from 15-feet to 30-feet depths, would not provide data useful in evaluating the site. The groundwater monitoring well hole had already shown no visual evidence of unusual conditions until the 50-foot level. Staining was identified, but did not appear to indicate

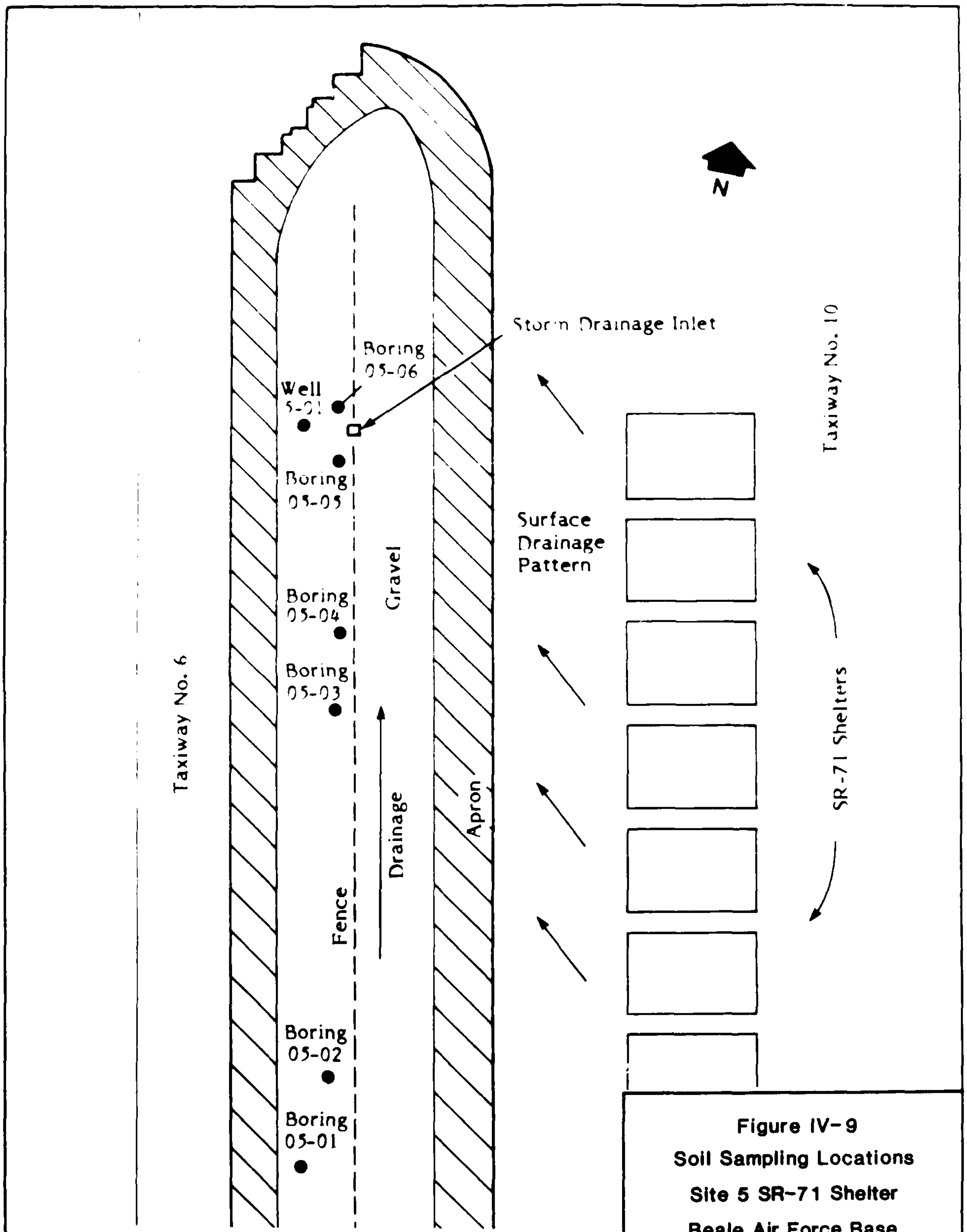
serious contamination. The field team decided that the groundwater sampling could provide the necessary information for this site.

o Site 5 -- SR-71 Shelters

Soil contamination at Site 5 is mostly concentrated at the north end of the gravel area between the SR-71 shelter apron and the flightline taxiway. Five sample borings and one background boring were completed at the site (see Figure IV-9). Boring 05-01, the background boring, was located near the taxiway and updrainage (south) from the rest of the borings. The location is also on the opposite side of the drainage from the shelter apron. A fence runs almost exactly along the lowest point of the drainage swale created between the taxiway and the SR-71 apron. Surface drainage from the apron generally flows east to the swale and then north along it to a storm sewer. Borings 05-01 through 05-06 were spaced along the fence in a line of approximately 600 feet. Borings were advanced to 16.5 feet, except Boring 05-05, which had a final sampling depth of 11.5 feet. Samples from 1.5 feet, 6.5 feet and 16.5 feet were analyzed for volatile organics, O&G and total phenolics. Table IV-6 shows the analytical results for these samples.

Analytical results from Borings 05-01, 02 and 03 showed no evidence of contamination. However, high organic vapor readings were taken in the field at Boring 05-03. Also, a blind field duplicate of the 16.5-foot sample from Boring 05-03 had an O&G value of 400 µg/g, while the original sample was reported below the method detection limit for O&G (100 µg/g). While this difference is not considered significant (400 µg/g is less than five times the detection limit, which is considered the level of quantification), it may indicate slight hydrocarbon contamination, taking into account the high organic vapor reading.

Borings 05-04 and 05-05 had slightly elevated O&G levels. Samples from 6.5 and 11.5 feet at Boring 05-06 were contaminated with volatile aromatics, primarily benzene, with O&G up to 4000 µg/g at 6.5 feet. However, due



Scale: 1" ≈ 120'
Note: See Figure I-3 for general location of this site.

Figure IV-9
Soil Sampling Locations
Site 5 SR-71 Shelter
Beale Air Force Base

AeroVironment Inc.

TABLE IV-6.

Soil Sampling Results

Site 5 - SR-71 Shelter

SITE 5 - SR-71 SHELTER   Sampled 11/13/85 & 11/14/85 for Oil & Grease, Phenols and 8010/8020
Acurex Report # 8511-039 UNITS-UG/G

ACUREX #	HV SAMPLE#	DEPTH (FT)	O&G	PHENOLS	8010 Methylene chloride	8010 Chloroform	8010 1,1,1-TCA	8010 T/E	8010 1,1,2-Trichloro ethane	8010 Chloromethane	8020 Benzene	8020 Toluene	8020 Ethyl Benzene	8020 Chloro benzene	8020 Xylenes	8020 Dichloro benzenes
904279	5-1-S1	1.5	<100	<1	0.001	0.0003						0.0005	0.0017?	0.0004?		[illegible]
904280	5-1-S2	6.5	100	<1	0.003	0.0004						[illegible]	0.0004?	[illegible]		
904282	5-1-S4	16.5	<100	<1	0.003	0.0004		0.0002				0.0002	0.0013?			
904283	5-2-S1	1.5	<100	<1	0.002	0.0004							0.0009?			
904284	5-2-S2	6.5	<100	<1	0.002	0.0003							0.0008?			
904286	5-2-S4	16.5	<100	<1	0.002	0.0003							0.0004?			
904287	5-3-S1	1.5	<100	<1	0.001	0.0003					0.0004?	0.0007?	0.0011	[illegible]	[illegible]	[illegible]
904288	5-3-S2	6.5	<100	<1	0.001	0.0003					0.0006?	0.0008?	0.001?	0.0005?	[illegible]	[illegible]
904290	5-3-S4	16.5	<100	<1	0.001	0.0003					0.0004?	0.0007?	0.0009?	0.0004?		[illegible]
904291	5-4-S1	1.5	500	<1	0.001	0.0003					0.0007?	0.0007?	0.0011	0.0005?	0.0004?	[illegible]
904292	5-4-S2	6.5	<100	<1	0.001	0.0003					0.0004	0.0007?	0.0012	0.0004?		[illegible]
810723	5-4-S4	16.5	400	<1	0.002	0.001	0.0004		0.0001			0.0003?	0.0021?	0.0002?		
810724	5-5-S1	1.5	400	<1	0.002	0.0006							0.001?			
810725	5-5-S2	6.5	400	<1	0.002	0.0005						[illegible]	[illegible]			
810726	5-5-S3	11.5	400	<1	0.002	0.0005	0.00003				0.000?	0.0004?	0.0006?			
810727	5-6-S1	1.5	400	<1	0.002	0.0005					0.0002?	0.0004?	0.0006?			
810728	5-6-S2	6.5	4000	<1	0.002	0.0004				0.000?	1.6?	0.11	0.42?			
810729	5-6-S3	11.5	1100	<1	0.003	0.0006	0.00004		0.0002?	0.0001		0.12				

Note: Only those results reported at concentrations above detection are presented.

Site 5 soil boring ("S") sample analytical data are presented in Appendix H, Laboratory Report No. 8511-039, beginning on Page H-106. Sample 5-1-S4 is in Laboratory Report No. 8511-033, beginning on Page H-69.

Data are reported by Acurex sample number.

The TTLC for TCE is 2040 μg/g.

to the [illegible] ogenetic found [illegible] samples, [illegible] sample from Boring [illegible] was an order of magnitude [illegible] vapor measurements were sufficiently high ([illegible] ppm [illegible] require containerization of cuttings.

In summary, volatile aromatics characteristic of [illegible] were detected at a depth of 11.5 feet in the northern boring, located downgradient from the SR-71 shelters. This is consistent with the visible staining of the soil (particularly along the northern portion of the apron) and the volatile organic measurements.

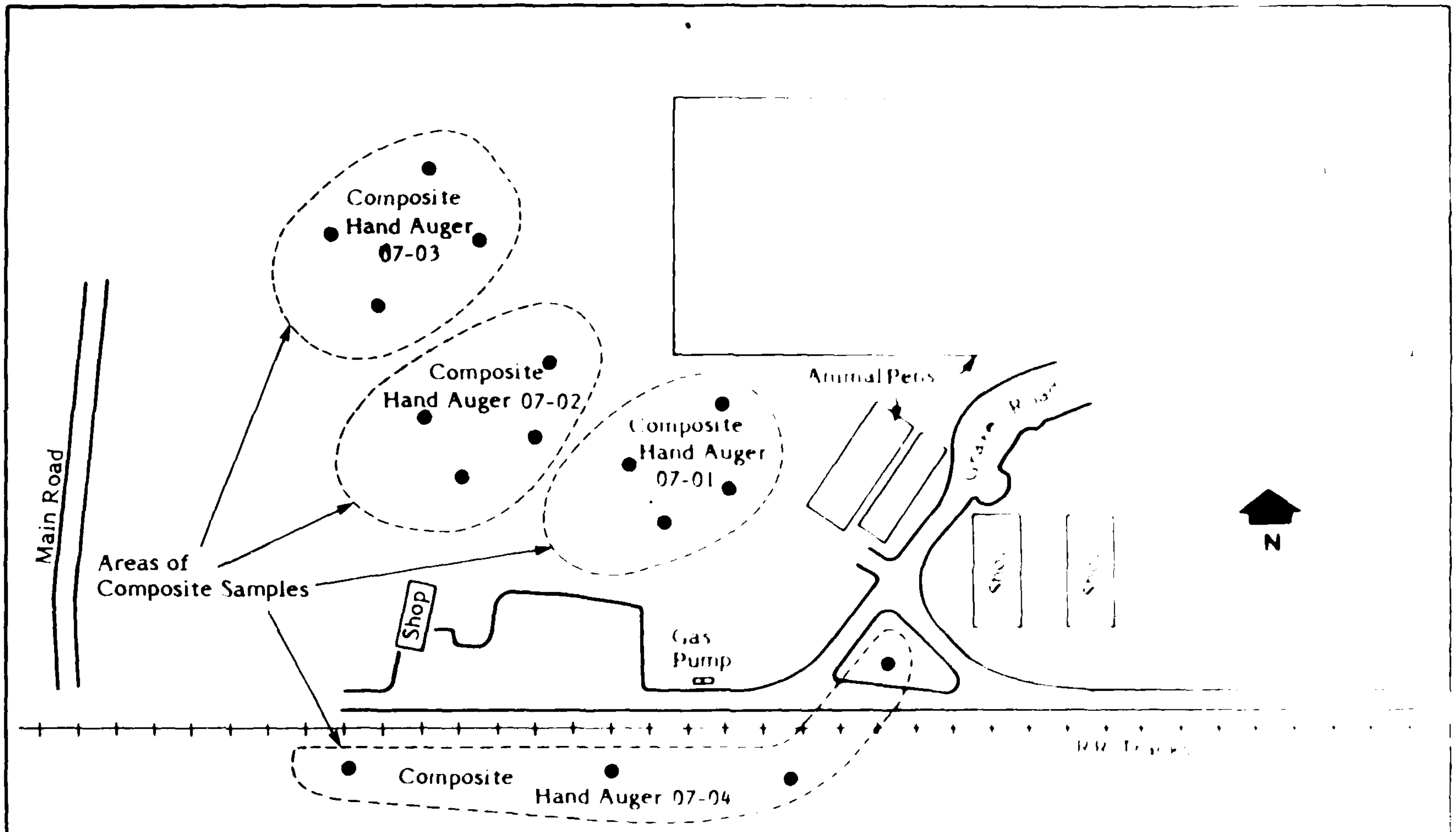
o Site 6 -- Landfill No. 2

No soil samples taken.

o Site 7 -- Biological Production

Surface soil at Site 7, the Biological Production Site, was sampled to identify potential contamination from the past burial of incinerator residue. The sampling was conducted in a loose grid pattern that included a large area adjacent to the gun club north of the railroad tracks and an area just south of the tracks (see Figure IV-10). Sixteen samples were collected from a depth of 0 to .5 feet. At the laboratory, four groups of four samples (related by vicinity) were composited and analyzed for VOCs and heavy metals. Table IV-7 shows the soil sampling results for Site 7.

The composite sample from an area south of the pheasant pens and north of the railroad tracks contained 12 µg/g silver, which is slightly elevated above background (approximately 4 µg/g) though not significantly so. Previous analyses of the residue indicate the level of silver present in the residue to be about 2 ppm (µg/g) (Engineering Science, 1984). No other contaminants were found above background levels.



Not to Scale

Note: See Figure I-3 for general location of this site.

Figure IV-10
Soil Sampling Locations
Site 7 Biological Production
Beale Air Force Base

AeroVironment Inc

TABLE IV-7.

Soil Sampling Results

Site 7 - Biological Production (DA-4)

SITE 7 - BIOLOGICAL PRODUCTION (DA-4)
Acurex Report # 8511-048

Sampled 11/20/85 for 8010/8020 and Metals
Units-UG/G

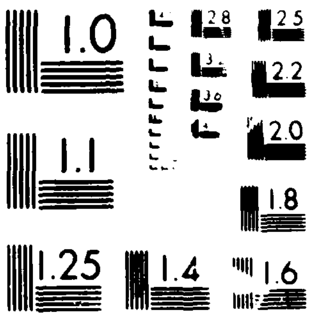
ACUREX #	AV SAMPLE#	DEPTH (FT)	Total Metals								8010				8020
			As	Ba	Cd	Cr	Pb	Hg	Se	Ag	Methylene chloride	Chloroform	1,1,1-TCA	Carbon Tetrachloride	Ethyl Benzene
810779-82	7-1-H1	0.5	13	89	0.6	20	12	<.05	0.4	12	0.002	0.0004			0.001
810783-86	7-2-H1	0.5	16	39	0.6	29	13	<.05	0.4	2.8	0.005	0.00042	0.00008		0.0014
810787-90	7-3-H1	0.5	12	82	0.6	25	11	<.05	<0.2	2.8	0.002	0.00022		.00004	0.0006
810791-94	7-4-H1	0.5	6.8	71	0.4	18	9	<.05	<0.2	6	0.002	0.0003			0.0003
DOHS TTLC:			500	10000	100	2500	1000	20	100	500					

Site 7 hand auger ("H") soil sample analytical data are presented in Appendix H, Laboratory Report No. 8511-048, beginning on Page H-139.

Data are reported by Acurex sample number.

Note: Only those results reported at concentrations above detection are presented.

AD-A183 968 INSTALLATION RESTORATION PROGRAM PHASE 2 3/4
CONFIRMATION/QUANIFICATION STAGE..(U) AEROVIRONMENT INC
MONROVIA CA R BAUER 29 MAY 87 AV-FR-86/517R2-VOL-1
UNCLASSIFIED F33615-83-D-4000 F/G 24/4 NL


1.0
2.8
2.5
2.2
2.0
1.1
1.8
1.25
1.4
1.6

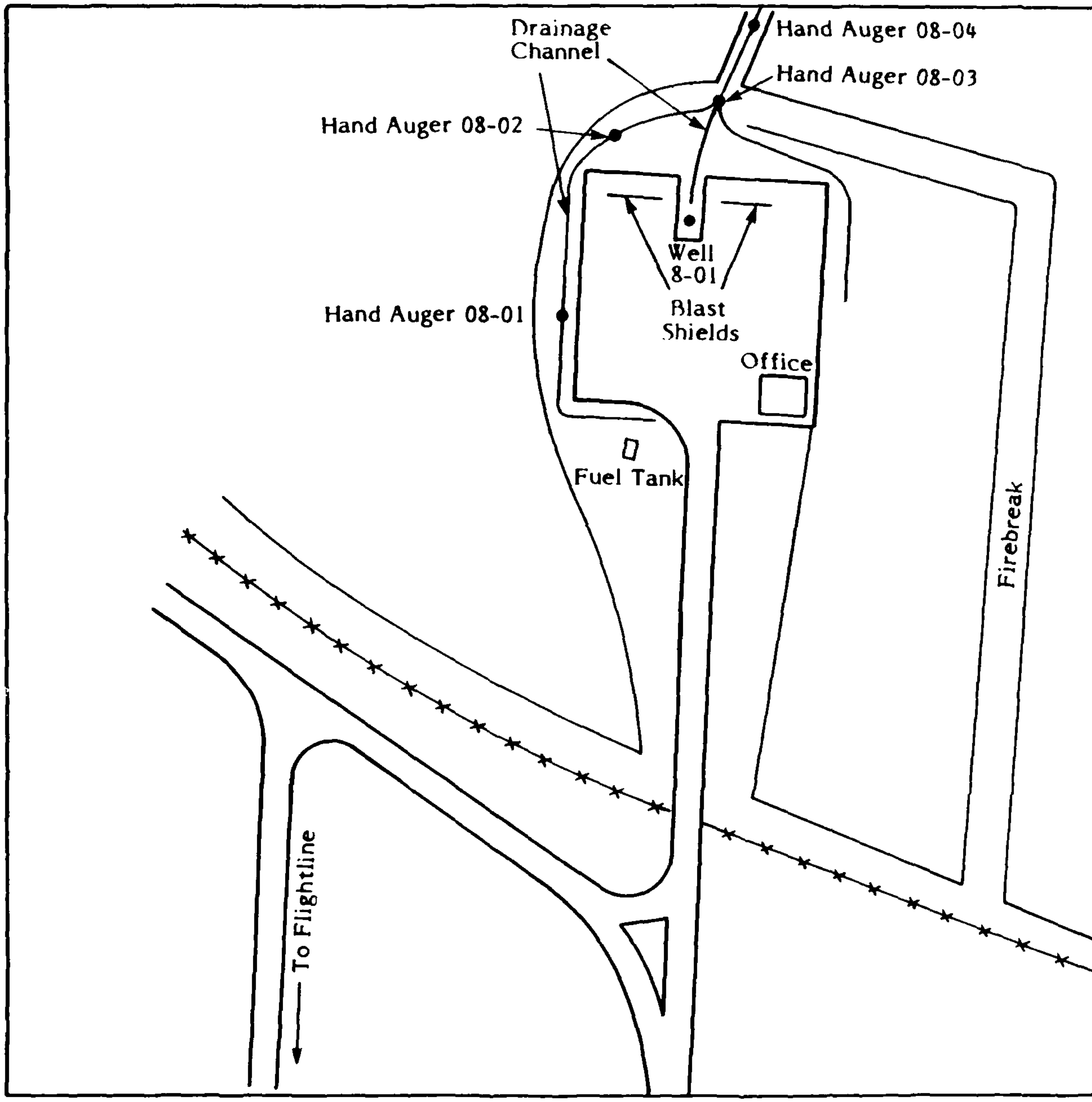
- Site 8 -- J-57 Test Cell

At Site 8, the J-57 Test Cell, samples were collected at 0 to .5 feet and 1 to 1.5 feet from three hand-auger borings located in the drainage channel at the edge of the paved area (see Figure IV-11). Samples were not collected from 1 to 1.5 feet at locations 08-02 and 08-04 because of the presence of cobbles in the channel. Four or five attempts were made at each location, but the samplers could not find sufficient soil to drive the sampling tool. The updrainage sampling location (Hand Auger 08-01) showed elevated O&G (700 µg/g) and petroleum hydrocarbons (1400 µg/g) in the deep sample, but no detectable VOCs. Oily stains were observed at this location. Table IV-8 gives the analytical results. No further evidence of contamination was found at Site 8.

- Site 9 -- Entomology Building 2560

Three soil borings were completed at Site 9 to identify possible contamination from pesticide mixing and cleanup activities routinely conducted in a small gravel, diked area adjacent to Building 2560 (see Figure IV-12). Boring 09-01, the background boring, was located southwest and updrainage from the mixing basin. Boring 09-03 was located approximately 25 feet down slope from the basin to identify potential runoff contamination. Boring 09-03 was sited inside the diked area, and drilled to a final depth of only 6.5 feet, due to difficult conditions. Borings 09-01 and 09-02 were completed to approximately 12 feet.

Table IV-9 presents the analytical results from Site 9. The samples collected from Boring 09-03 in the mixing basin contained low levels of Chlordane. It was detected at 0.9 µg/g in the 1.5-foot sample, which is at the level of quantification (LOQ) for the analyte and is therefore considered significant (LOQ is considered to be five to ten times the method detection limit, which is 0.08 µg/g for Chlordane). The concentration dropped to 0.1 µg/g in the 6.5-foot sample from that boring. The DOHS TTLC value for Chlordane is 2.5 µg/g. No other evidence of contamination was found at Site 9.



Scale: 1" ≈ 120'
Note: See Figure I-3 for general location of this site.

Figure IV-11
Soil Sampling Locations
Site 8 J-57 Test Cell
Beale Air Force Base
AeroVironment Inc.

TABLE IV-8.

Soil Sampling Results

Site 8 - J 57 Test Cell (DA-6)

SITE 8 - J 57 TEST CELL (DA-6) Sampled 11/20/85 for Oil & Grease, Petroleum Hydrocarbons, Phenols and 8010/8020
Acurex Report # 8511-048 UNITS-UG/G

ACUREX #	AV SAMPLE#	DEPTH (FT)	O&G	PET HC	PHENOLS	8010				8020		
						Methylene chloride	Chloroform	1,1,1-TCA	1,1- DCE	Benzene	Toluene	Ethyl Benzene
810801	8-1-H1	0.5	<100	<100	<1	0.005	0.00056	0.00005				0.0006
810802	8-1-H2	1.5	700	1400	<1	0.007		0.00008				
810803	8-2-H1	0.5	<100	<100	<1	0.017	0.00048	0.00004				
810805	8-3-H1	0.5	<100	<100	<1	0.018	0.0072	0.00018				0.0005
810806	8-3-H2	1.5	<100	<100	1	0.053	0.001	0.00005	0.00018		0.0002	0.0009
810807	8-4-H1	0.5	<100	100	<1	0.016	0.41			0.0003	0.0003	0.0003

Note: Only those results reported at concentrations above detection are presented.

Site 8 hand auger ("H") soil sample analytical data are presented in Appendix H, Laboratory Report No. 8511-048, beginning on Page H-139.

Data are reported by Acurex sample number.

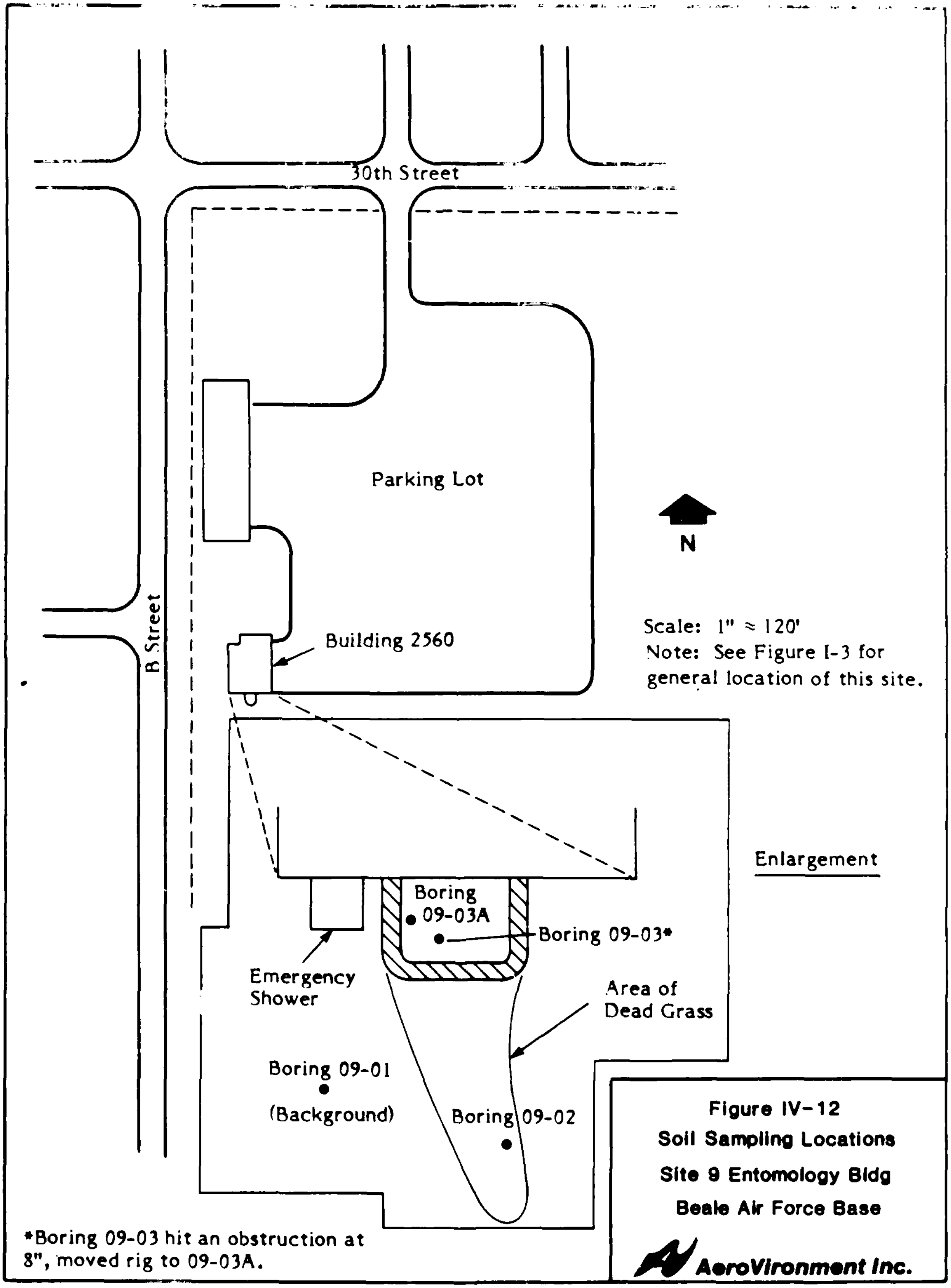


Figure IV-12
Soil Sampling Locations
Site 9 Entomology Bldg
Beale Air Force Base

TABLE IV-9.

Soil Sampling Results

Site 9 - Entomology Building 2560 (DA-9)

SITE 9 - ENTOMOLOGY BLDG 2560 (DA-9)
Acurex Report # 8510-048 & 8511-003

Sampled 10/23/85 & 11/1/85 for 509A&B
UNITS-UG/G

ACUREX #	AV SAMPLE#	DEPTH (FT)	509A Chlordane
904221	9-1-S1	6.5	
904224	9-1-S2	12.5	
904222	9-2-S1	6.5	
904223	9-2-S2	11.5	
904243	9-3-S1	1.5	0.9
904244	9-3-S2	6.5	0.1

DOHS TTLC for Chlordane is 2.5 µg/g

Note: Only those results reported at concentrations above detection are presented.

Acurex Report 048 is for samples 9-1-S1,2 and 9-2-S1,2

Acurex Report 003 is for samples 9-3-S1,2

Site 9 soil boring ("S") sample analytical data are presented in Appendix H, Laboratory Report No. 8510-048, beginning on Page H-17 (No. 904221 - No. 901224), and Laboratory Report No. 8511-003, beginning on Page H-58 (No. 904243 - No. 904244).

Data are reported by Acurex sample number.

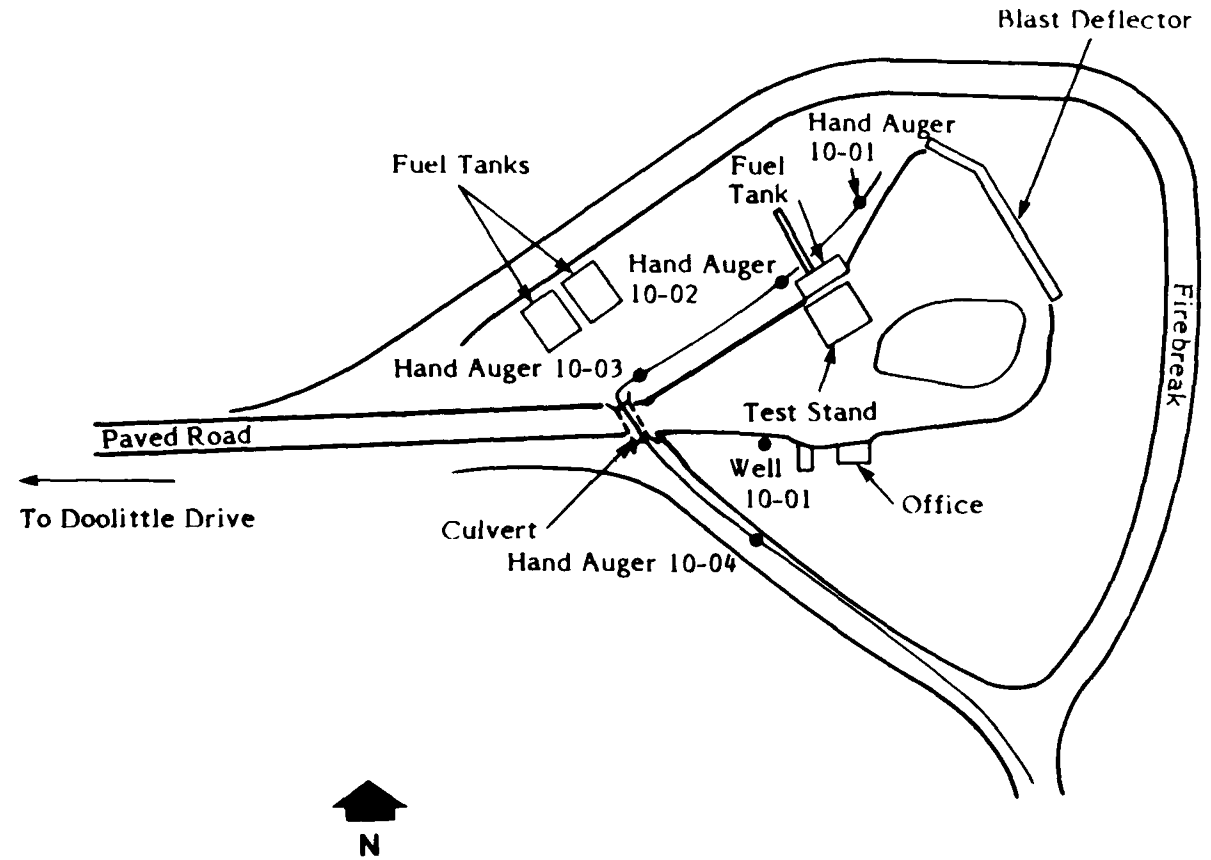
o Site 10 -- J-58 Test Cell

At Site 10, the J-58 Test Cell, hand-auger soil samples were collected from 0- to .5-foot and 1- to 1.5-foot depths at four locations in the channel (see Figure IV-13). A 1- to 1.5-foot sample was not collected at location 10-04 because of cobbles in the bottom of the drainage channel. Four unsuccessful attempts were made to collect an acceptable sample. Samples taken from the channel near an above ground storage tank (north of the test cell) had significant levels of O&G (4000-1600 µg/g) and petroleum hydrocarbons (4700-1600 µg/g) to 1.5 feet in depth (the deepest sample taken). Considerable discoloration and odor were observed in the field. Table IV-10 shows the analytical data for the soil samples. The rest of the surface samples contained only slightly elevated levels of O&G and petroleum hydrocarbons. No significant levels of VOCs were detected in any of the samples.

o Site 11 -- AGE Maintenance

A total of four soil borings were made at Site 11 (see Figure IV-14). Boring 11-01, the background boring located north of Building 1225 and up gradient from the AGE building, was sampled at 6.5-foot and 16.5-foot depths. Borings 11-01, 03 and 04 were located along the eastern edge of the paved parking lot surrounding the building, approximately 75 to 100 feet apart and directly adjacent to the pavement. Samples were taken from each boring at 1.5-foot, 6.5-foot and 16.5-foot depths. In addition, eight hand-auger soil samples were taken from four locations in the drainage ditch that runs parallel to and accepts runoff from the AGE parking lot. Hand-Auger Holes 11-04, 03 and 02 correspond in location to Borings 11-02, 03 and 04, respectively.

Table IV-11 shows the analytical results. Hydrocarbon contamination was identified at the surface (1.5 feet) in Borings 11-02, 03 and 04. O&G values at 1.5 feet ranged from 1500 to 7000 µg/g and showed a decreasing trend from Boring 11-02 to Boring 11-04 (north to south). Elevated levels of volatile aromatics characteristic of gasoline were detected in the 1.5-foot sample from Boring 4, which had the highest organic vapor reading of the three borings.



Scale: 1" ≈ 120'

Note: See Figure I-3 for general location of this site.

Figure IV-13

Soil Sampling Locations

Site 10 J-58 Test Cell

Beale Air Force Base

AeroVironment Inc.

TABLE IV-10.

Soil Sampling Results

Site 10 - J-58 Test Cell

SITE 10- J-58 TEST CELL
Acurex Report # 8604-037

Sampled 4/16/86 for Oil & Grease, Petroleum Hydrocarbons, Phenols and 8010/8020
UNITS- UG/G

						8010				8020
ACUREX #	AV SAMPLE#	DEPTH (FT)	O&G	PET HC	PHENOLS	Methylene chloride	trans-1,2-DCE	Chloroform	Bromodi-chloromethane	Xylenes
906108	10-1-H1	0.5	600	600	<1	0.0017				0.0046
906103	10-1-H2	1.5	<100	<100	<1	0.0031				
906105	10-2-H1	0.5	4000	4700	<1	0.0093	0.0029	0.0006	0.0003	
906104	10-2-H2	1.5	1600	1600	<1	0.0021	0.0006	0.0002		
906121	10-3-H1	0.5	500	500	19	0.0009				
906123	10-3-H2	1.5	<100	<100	<1	0.0014				
906122	10-4-H1	0.5	200	200	<1	0.0009		0.00009		

Note: Only those results reported at concentrations above detection are presented.

Site 10 hand auger ("H") soil sample analytical data are presented in Appendix H, Laboratory Report No. 8604-044, beginning on Pages H-307 (phenols), H-310 (petroleum hydrocarbons, oil and grease) and H-357 (8010/8020).

Data are reported by Acurex sample number.

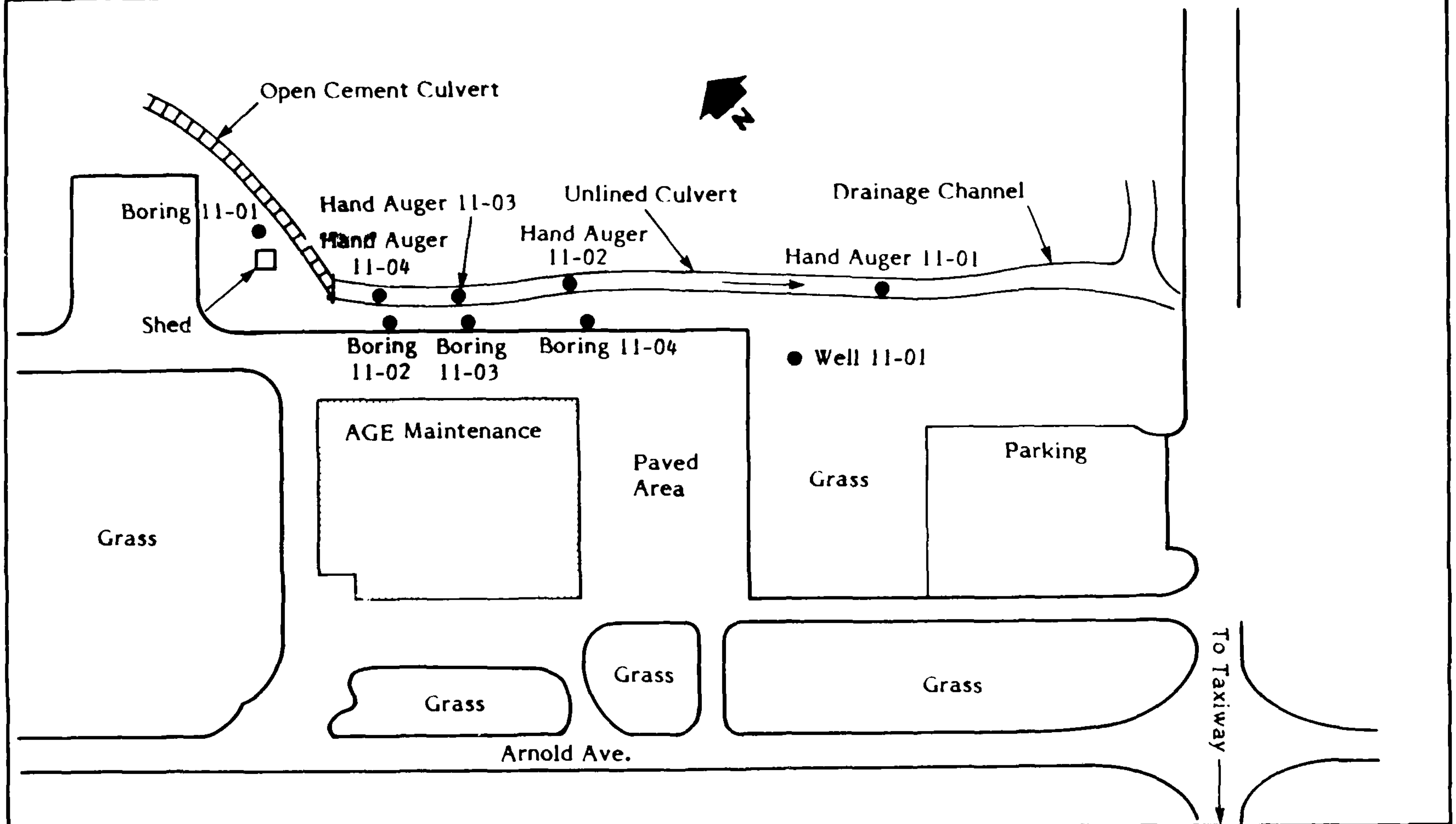


Figure IV-14
Soil Sampling Locations
Site 11 AGE Maintainance
Beale Air Force Base

AeroVironment Inc.

Scale: 1" ≈ 120'
Note: See Figure I-3 for general location of this site.

TABLE IV-11.

Soil Sampling Results

Site 11 - AGE Maintenance

SITE 11 - AGE MAINTENANCE (DA-7)
Acurex Report # 8510-048, 8510-054 and 8511-052

Sampled 10/24/85 and 10/25/85 for Oil & Grease, Phenols and 8010/8020
UNITS-UG/G

					8010								8020						
ACUREX #	AV SAMPLE #	DEPTH (FT)	O&G	PHENOLS	Methylene chloride	Trans-1,2-DCE	Chloroform	1,1,1 TCA	TCE	Tetrachloro ethane	Dichloro benzenes	1,1,2 Tri-chloro ethane	Chlorobenzene	Benzene	Toluene	Ethyl Benzene	Chloro benzenes	Xylenes	Dichloro benzenes
904226	11-1-S1	6.5	<100	<1	0.007		0.0007		0.0001										
904225	11-1-S2	16.5	<100	<1	0.015		0.001		0.0001										
904227	11-2-S1	1.5	7000	1.6	0.033	0.0002	0.006	0.0001	0.003		0.0005			0.011	0.014	0.013	0.042	0.011	0.032
904230	11-2-S2	6.5	<100	<1	0.029	0.0001	0.002												
904248	11-3-S1	1.5	3900	1	0.031	0.0004	0.002	0.0001	0.005	0.002		0.0001		0.0002	0.0014	0.0006	0.001	0.0003	[illegible]
904246	11-3-S2	6.5	<100	<1	0.016		0.001							0.0015	0.0005	0.0003	0.0006	0.0002	[illegible]
904249	11-4-S1	1.5	1500	<1	0.003		0.0001	0.0001					0.0003	1.6	1.3	2.4	3.4	1.6	[illegible]
904250	11-4-S2	6.5	<100	<1	0.014								0.0009	0.0045	0.0015	0.002	0.004	0.001	[illegible]
810859	11-1-H1	0.5	<100	<1	0.002		0.00057	0.00002								0.0012			
810852	11-2-H1	0.5	<100	<1	0.002		0.00043									0.0021			
810853	11-2-H2	1.5	<100	<1	0.003		0.00069									0.0017			
810824	11-3-H1	0.5	<100	<1	0.004		0.00037								0.0013	0.001	0.0003		
810825	11-3-H2	1.5	<100	<1	0.003		0.00042									0.0011			
810849	11-4-H1	0.5	<100	<1	0.002		0.00142								0.0002	0.0011			
810850	11-4-H2	1.5	<100	<1	0.002		0.00039								0.0002	0.0009			

Note: Only those results reported at concentrations above detection are presented.

Acurex Report 048 is for samples 11-1-S1,2 and 11-2-S1,2

Acurex Report 054 is for samples 11-3-S1,2 and 11-4-S1,2

Acurex Report 052 is for all "H" samples

Site 11 soil boring ("S") sample analytical data are presented in Appendix H, Laboratory Report No. 8510-048 beginning on Page H-6 and Report No. 8510-054, beginning on Page H-31.

Site 11 hand auger ("H") soil sample analytical data are presented in Appendix H, Laboratory Report No. 8511-052, beginning on Page H-171.

The DOHS TTLC for TCE is 2040 μg/g.

[illegible] presence of volatile organic [illegible] with different organic constituents [illegible] chlorinated [illegible] degreasing solvents. [illegible] contaminat[illegible] as samples from 6.5 feet showed no evidence of further contamination [illegible] borings.

Hand-auger samples taken inside the drainage [illegible] signs of contamination to a final depth of 1.5 feet. The 1- to 1.5-foot [illegible] Hand-Auger Hole 11-01 was not collected because of cobbles [illegible] bottom.

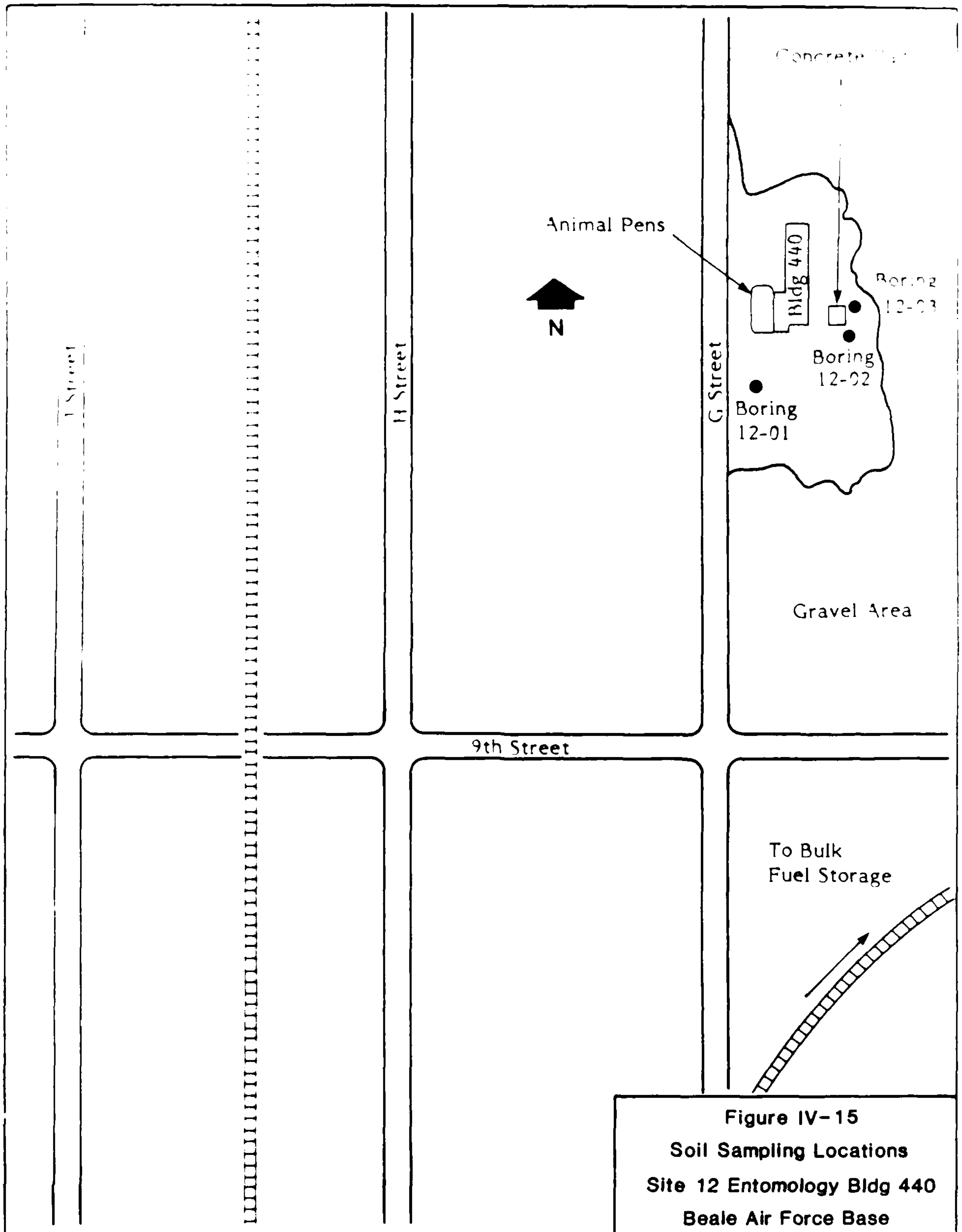
o Site 12 -- Entomology Building 445

Three soil borings were completed at Site 12 (see Figure IV-[illegible]). Boring 12-01, the background boring, was located approximately 75 feet south of Building 445. Borings 12-02 and 12-03 were drilled near the edge of a [illegible] concrete pad located approximately 30 feet east of the southeast corner of the building. The pad may have been used as a pesticide mixing and washing area at the time the building served as an entomology shop (1965 to 1980).

Samples were taken from each boring at depths of 1.5 feet, 6.5 feet and 11.5 feet. The deep samples were submitted to the laboratory but not analyzed, pending results from analysis of the shallow samples for pesticides and herbicides. Table IV-12 shows the laboratory results. 4,4-DDE, an insecticide, was detected in Boring 12-03 at a level twice the method detection limit, but is not considered significant. No further evidence of pesticide or herbicide contamination was found at the site. Deep samples were not analyzed since the upper soils were not contaminated.

o Site 13 -- Landfill No. 1

No soil samples taken.



Scale: 1" = 120'

Note: See Figure I-3 for general location of this site.

Figure IV-15

Soil Sampling Locations

Site 12 Entomology Bldg 440

Beale Air Force Base

AeroVironment Inc.

TABLE IV-12.

Soil Sampling Results

Site 12 - Entomology Building No. 440

SITE 12- ENTOMOLOGY BUILDING #440
Acurex Report # 8511-033

Sampled 11/13/85 for 509 A&B
UNITS- UG/G

ACUREX #	AV SAMPLE#	DEPTH (FT)	509A 4-4-DDE
904270	12-1-S1	1.5	
904271	12-1-S2	6.5	
904273	12-2-S1	1.5	
904274	12-2-S2	6.5	
904276	12-3-S1	1.5	0.04
904277	12-3-S2	6.5	

Note: Only those results reported at concentrations above detection are presented.

Site 12 soil boring ("S") sample analytical data are presented in Appendix H, Laboratory Report No. 8511-033, beginning on Page H-77.

Data are reported by Acurex sample number.

o Site 14 -- Transformer Drainage

At Site 14, the Transformer Drainage Area, surface hand-auger samples were collected from 12 locations in a grid pattern within the unpaved bermed area (see Figure IV-16). Samples were collected from 0 to 6 inches at all 12 locations. The original sampling plan called for collecting two samples at each location, one from 0-1 foot and one from 1-2 feet, but analyzing only one of the two samples from each sampling location. The field crew decided that all samples should be collected from the same depth (0-1 ft) to eliminate the possibility of not detecting localized surface contamination. Using this method, the lateral extent of any contamination could be defined, even though additional vertical sampling would later be needed if contaminants were found. Using the original method, neither vertical or lateral conditions could be fully defined. In collecting the 0-1 foot sample, the upper six inches were used for primary analysis (because if PCBs exist, they would be in the uppermost soil) and the lower six inches were collected for Air Force splits. As a result, all analytical results in this report are for the top six inches of soil at the site.

Table IV-13 shows the analytical results. One sample, taken from an area of bare soil with no vegetation, had high O&G contamination (38,000 ug/g) and contained 5.3 ug/g of the PCB Aroclor 1260. A second sample taken in the same bare area had an elevated, but lower, O&G concentration and no detectable PCBs. No other evidence of contamination was found in the remaining samples, indicating the contamination is probably localized.

o Site 15 -- Landfill No. 3

No soil samples taken.

o Site 16 -- Explosives Ordnance Disposal Area (EOD)

Surface soil samples were collected from the scrap metal disposal trench at Site 16, the Explosives Ordnance Disposal Area (see Figure IV-17). The current ordnance burn pit was evaluated, but no sample was collected because

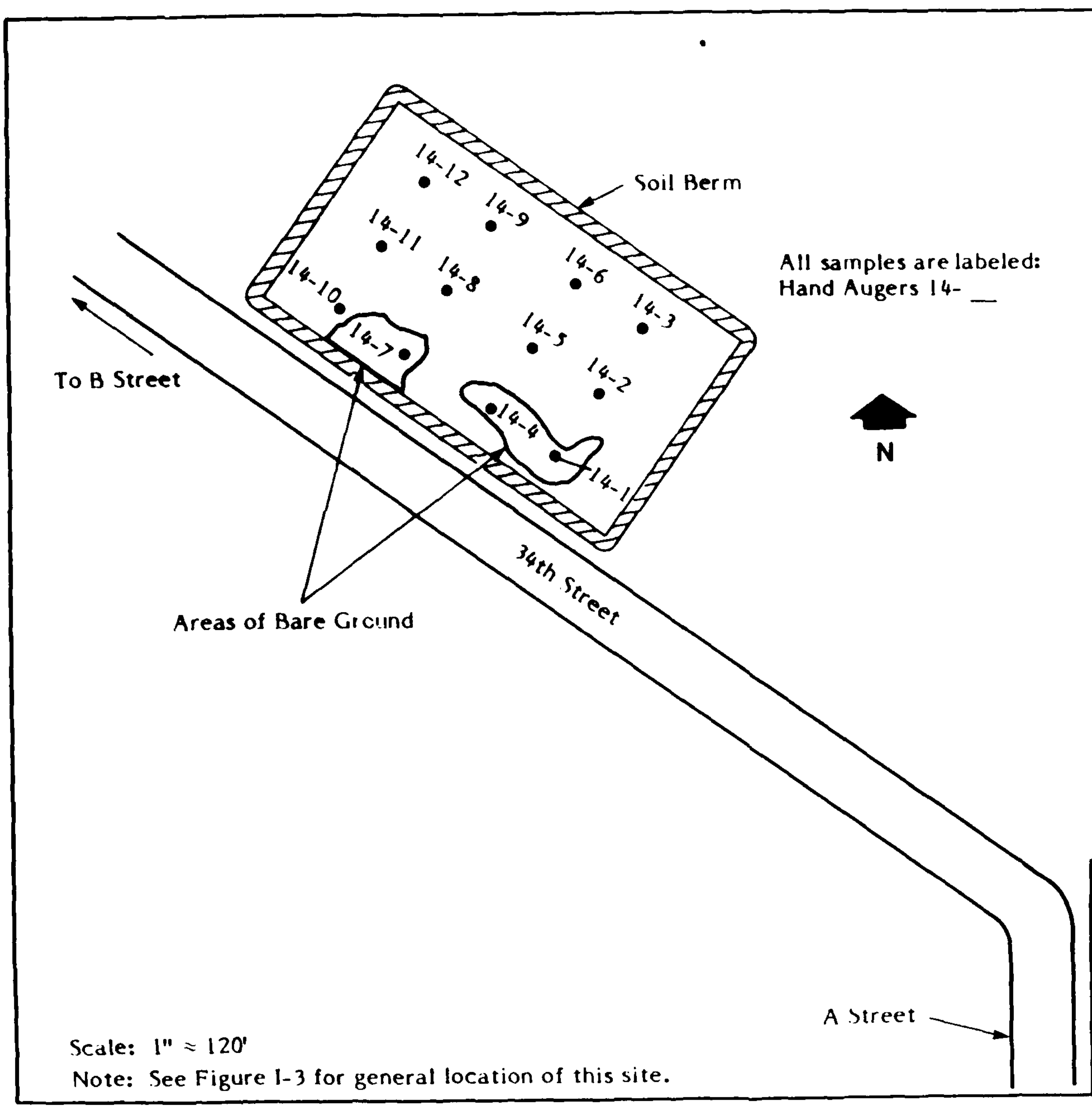


Figure IV-16
Soil Sampling Locations
Site 14
Transformer Drainage Area
Beale Air Force Base

AeroVironment Inc.

TABLE IV-13.

Soil Sampling Results

Site 14 - Transformer Drainage Area (DR-8)

SITE 14 - TRANSFORMER DRAINAGE AREA (DR-8)
Acurex Report # 8511-052

Sampled 11/22/85 for Oil & Grease and PCBs
UNITS-UG/G

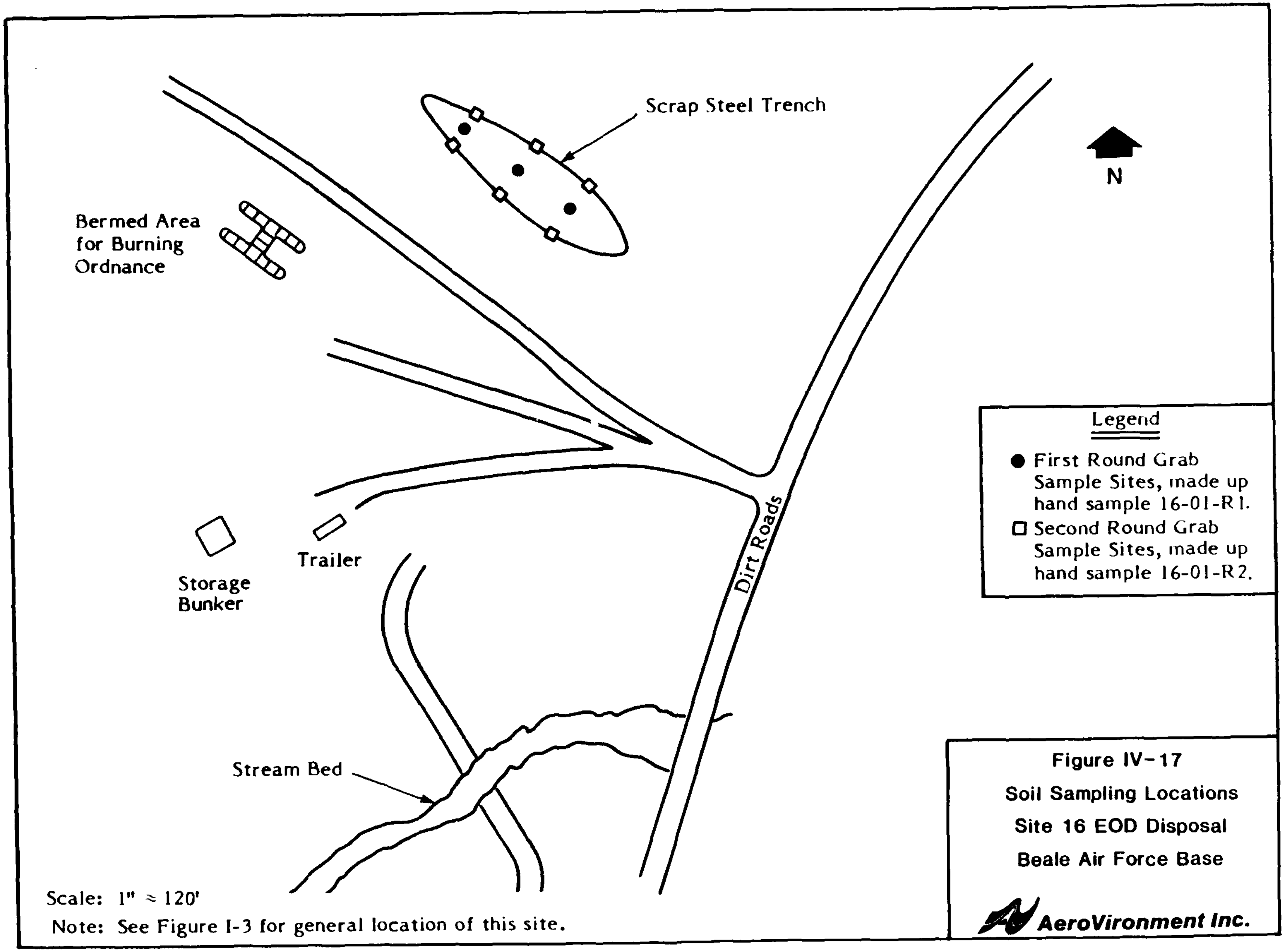
ACUREX #	AV SAMPLE#	DEPTH (FT)	O&G	PCB Aroclor 1260
810821	14-1-H1	0.5	1900	
810822	14-2-H1	0.5	<100	
810819	14-3-H1	0.5	<100	
810820	14-4-H1	0.5	38000	5.3
810823	14-5-H1	0.5	<100	
810848	14-6-H1	0.5	<100	
810851	14-7-H1	0.5	<100	
810857	14-8-H1	0.5	<100	
810854	14-9-H1	0.5	<100	
810858	14-10-H1	0.5	<100	
810855	14-11-H1	0.5	<100	
810856	14-12-H1	0.5	<100	

TTLC for PCB - 50 μg/g

Note: Only those results reported at concentrations above detection are presented.

Site 14 hand auger ("H") soil sample analytical data are presented in Appendix H, Laboratory Report No. 8511-052, beginning on Page H-189.

Data are reported by Acurex sample number.



Note: See Figure I-3 for general location of this site.

Figure IV-17
Soil Sampling Locations
Site 16 EOD Disposal
Beale Air Force Base

discussions with EOD personnel indicated no potential contamination existed outside the trench. Samples taken from three locations along the bottom of the scrap metal disposal trench were composited into one in the laboratory (Hand Sample 16-1-R1) and analyzed for total metals and explosives (RDX, HMX, TNT). Table IV-14 gives the results of soil sampling at the EOD.

The trench soil was found to be contaminated with chromium, barium and lead. Lead was found at 14,000 µg/g (1.4% by weight), which greatly exceeds the TTLC of 1000 µg/g. (Background levels at other sites are about 10 µg/g.) An unidentified yellow powder was observed in the trench at the time of sampling and may have contributed to the high concentration of metals. No evidence of explosive residues was found. Because of the high metal concentrations, the trench was resampled five months later, at which time it contained several feet of water. During the second sampling, surface soil samples were taken around the perimeter of the trench at the waterline and approximately six inches beneath the water surface. Three samples were again composited in the laboratory for metals analysis. Concentrations of metals in a composite of these samples were lower than in the original sample, but chromium and lead were still present at significant levels. The metals appear to be in an insoluble form, based on the results of an EP Toxicity Test performed on the second round sample. The EP Toxicity Test showed lead at only 0.26 ppm weight per volume in the leachate.

- <u>Site 17 -- Best Slough</u>

At Site 17, Best Slough, four soil borings were sited around the perimeter of a small trench containing rusting 55-gallon drums, one boring was located 220 feet west of the trench, and the background boring was located along the fence at the northwest edge of the site (see Figure IV-18). Samples were collected at 5-foot and 15-foot depths and analyzed for O&G, VOCs, total phenolics and pesticides/herbicides. Two surface hand-auger samples were also collected from each of three trenches at the site and analyzed for the same parameters. Table IV-15 shows the laboratory results for these samples. No detectable concentrations of any of the analytes were found.

TABLE IV-14.

Soil Sampling Results

Site 16 - EOD Disposal

SITE 16 - EOD DISPOSAL Sampled 11/22/85 for Total Metals & Explosive Scan (Composite) UNITS UG/G (TOTAL)
Report # 8511-052 & 8604-044BB Sampled 4/17/86 for Total Metals & EP Tox Metals (Composite) UNITS UG/L (EP TOX)

ACUREX #	AV SAMPLE #	DEPTH (FT)	As		Ba		Cd		Cr		Pb		Hg		Se		Ag	
			TOTAL	EP TOX	TOTAL	EP TOX	TOTAL	EP TOX	TOTAL	EP TOX	TOTAL	EP TOX	TOTAL	EP TOX	TOTAL	EP TOX	TOTAL	EP TOX
810860-62	16-1-R1	0.2	24		1500		6.8		2000		14000		<.05		<0.2		0.8	
906125 26	16-1-R2	0.2	<0.2	<10	100	480	4	30	340	20	2100	2.0	<0.05	<1	<0.2	<10	0.6	<10
DOHS TTLC:			500		10,000		100		2500		1000		20		100		500	

Acurex Report 052 is for Sample 16-1-R1

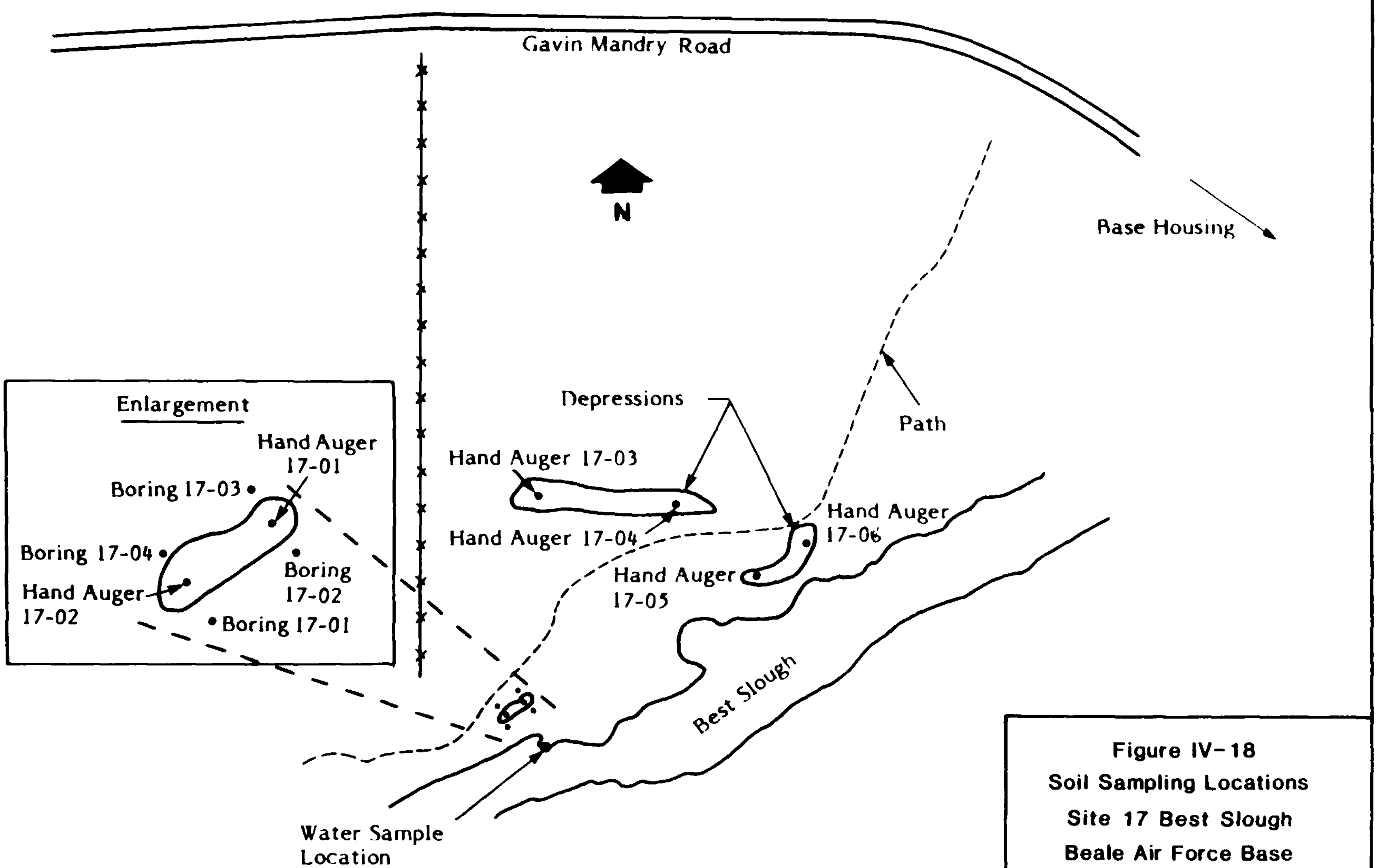
Acurex Report 044BB is for Sample 16-1-R2

Results for explosives scan showed all compounds not detected.

Site 16 soil grab ("R") sample analytical data are presented in Appendix H, Laboratory Report No. 8511-052, beginning on Page H-192 and Laboratory Report No. 8604-044BB, beginning on Page H-330.

Data are reported by Acurex sample number.

Explosives scan results for composite sample 810860-810862 are presented in Appehdix H on Page H-381. Acurex Report 044BB is for Sample 16-1-R2.



Scale: 1" ≈ 120'

Note: See Figure I-3 for general location of this site.

Figure IV-18
Soil Sampling Locations
Site 17 Best Slough
Beale Air Force Base

AeroVironment Inc.

TABLE IV-15.

Soil Sampling Results

Site 17 - Best Slough

SITE 17- BEST SLOUGH
Acurex Report # 8511-052 & 8510-048

Sampled 11/21/85 (hand auger samples) for Oil & Grease, Phenols, 509 A&B and 8010/8020
Sampled 10/22/85 (auger rig samples) for Oil & Grease, Phenols, 509 A&B and 8010/8020
UNITS: UG/G

					8010											8020					[illegible]		
ACUREX	AV #SAMPLES	DEPTH (FT)	O&G	PHENOL	Methylene Chloride	trans-1,2 DCE	Chloroform	1,1,1 TCA	TCE	Tetrachloroethane	Dichlorobenzenes	1,1,2 Trichloroethane	Chloromethane	1,1 DCE	Chlorobenzene	Benzene	Toluene	Ethyl Benzene	Chlorobenzene	Xylenes	2,4 D	2,4,5 T	Silvex
810813	17-1-H1	0.5	<100	<1	0.004		0.00048									0.0003	0.0002	0.0007					
810814	17-2-H1	0.5	<100	<1	0.004		0.00032			0.0006								0.0005					
810815	17-3-H1	0.5	<100	<1	0.002		0.00037	0.00004								0.0002	0.0006	0.0007	0.0004	0.0003			
810816	17-4-H1	0.5	<100	<1	0.002									.0002			0.0003	0.001	0.0002				
810817	17-5-H1	0.5	<100	<1	0.002		0.0031											0.0008					
810818	17-6-H1	0.5	<100	<1	0.002		0.00037	0.00027										0.0009					
904194	17-1-S1	5	<100	<1	0.016	0.0001	0.002		0.001	0.0004													
904195	17-1-S2	15	<100	<1	0.01		0.0006		0.008	0.002		0.008									<0.1	<0.1	<0.1
904196	17-2-S1	5	<100	<1	0.006		0.0009		0.0003	0.002	0.002		0.0008										
904191	17-2-S2	15	<100	<1	0.02		0.002		0.0002														
904192	17-3-S1	5	<100	<1	0.004		0.0008		0.0003												<0.1	<0.1	<0.1
904193	17-3-S2	15	<100	<1	0.012		0.001		0.0002														
904215	17-4-S1	5	<100	<1	0.007		0.0009		0.0005				0.0001		0.0003						<0.1	<0.1	<0.1
904216	17-4-S2	15	<100	<1	0.02	0.0001	0.001		0.0004														
904217	17-5-S1	5	<100	<1	0.008		0.0007		0.0001				0.0001										
904218	17-5-S2	15	<100	<1	0.009		0.0009		0.0001														
904219	17-6-S1	5	<100	<1	0.025		0.002	0.0001	0.0001				0.0001										
904220	17-6-S2	15	<100	<1	0.015		0.001		0.0002														

Note: Only those results reported at concentrations above detection are presented.

Site 17 soil boring ("S") sample analytical data are presented in Appendix H, Laboratory Report No. 8510-048, beginning on Page H-3.

Site 17 hand auger ("H") soil sample analytical data are presented in Appendix H, Laboratory Report No. 8511-052, beginning on Page H-174.

Data are reported by Acurex sample number.

The DOHS TTLC for TCE is 2040 µg/g.

o Site 18 -- Bulk Fuel Storage Area

At Site 18, the Bulk Fuel Storage Area, Boring 18-01, the background boring, was located at the south edge of the main aviation gasoline facility, outside the fence (see Figure IV-19 and Table IV-16). Boring 18-02 was drilled about 100 feet east of Boring 18-01 in a small drainage ditch that runs north-south and drains the fuel storage facility. This location was selected to determine whether any contamination has been carried off site with surface runoff. Boring 18-03 was located at the west edge of the motor gasoline storage facility, outside the fence near a railcar-unloading station. This location was selected to identify evidence of past spills reported to have occurred during tank car off-loading. Boring 18-04, located inside the main facility, was sited at the southwest corner of the facility drainage ditch (outside the bermed area) to investigate spillage or leakage that may have occurred during fuel transfer.

Table IV-16 shows the analytical results from Site 18. Most of the samples from Borings 18-01, 02 and 03 had levels of O&G and petroleum hydrocarbons (400/300 µg/g) slightly above background concentrations. These values are not considered significant for the following reasons: (1) Most of the O&G values in the laboratory analysis batch were reported as 400 µg/g, indicating a potential analytical background problem. (2) Samples from the background boring were reported to have 400 µg/g O&G at the surface and at 16.5 feet, which was unexpected. (3) No visible evidence of contamination was observed in the field.

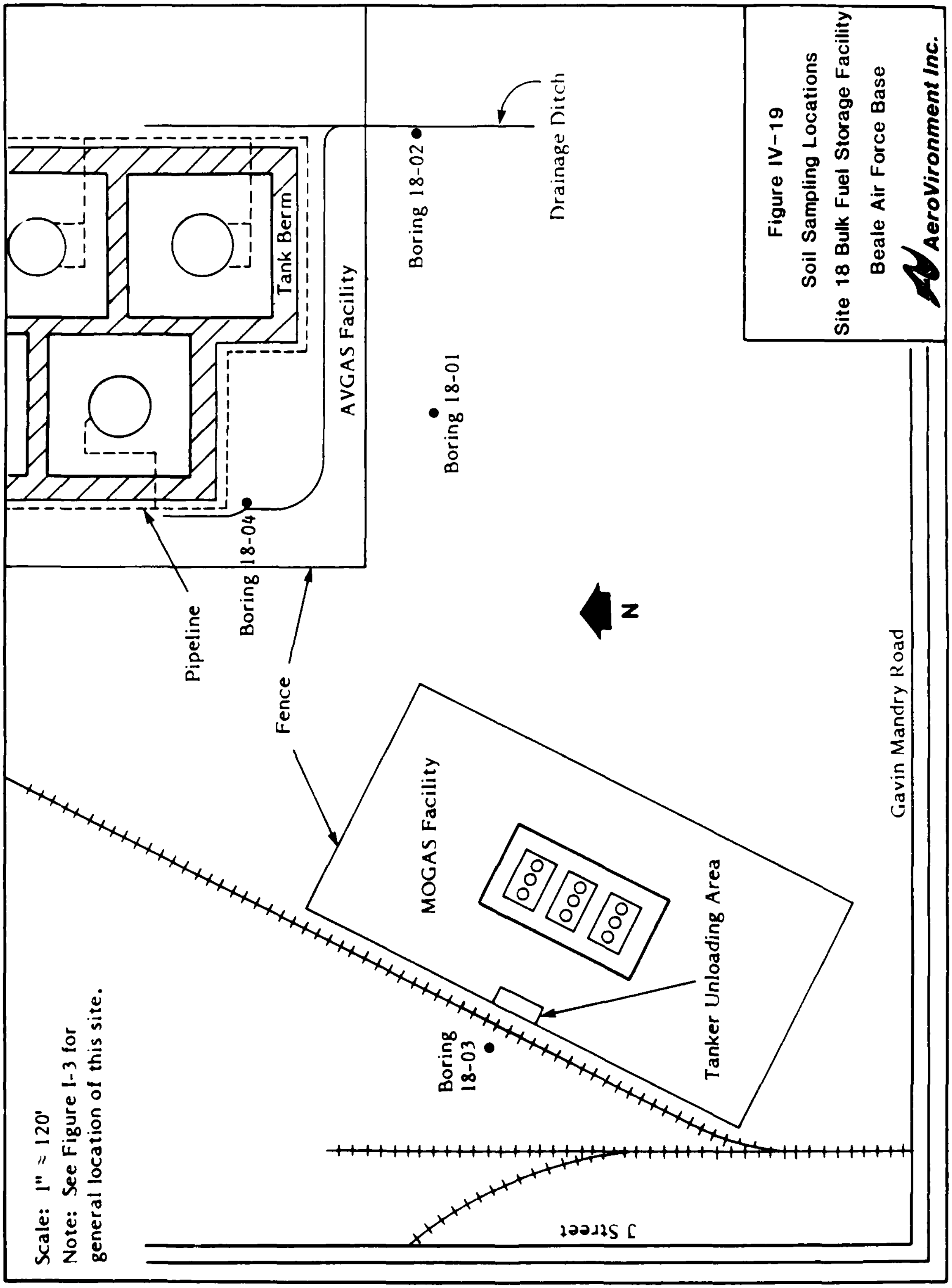


Figure IV-19
Soil Sampling Locations
Site 18 Bulk Fuel Storage Facility
Beale Air Force Base

TABLE IV-16.

Soil Sampling Results

Site 18 - Bulk Fuels Storage Facility

SITE 18 - BULK FUEL STORAGE Sampled 11/15/85 for Oil & Grease, Petroleum & Hydrocarbons, Phenols, Lead and 8010/8020
Acurex Report # 8511-039 UNITS-UG/G

							8010			8020			
ACUREX #	HV SAMPLE#	DEPTH (FT)	O&G	PET HC	PHENOLS	Pb	Methylene chloride	trans-1,2-DCE	Chloroform	Benzene	Toluene	Ethyl Benzene	Chloro-benzene
810731	18-1-S1	1.5	400	400	<1	11	0.002	0.0001	0.0003	0.0003	0.0004	0.0013	0.0003
810733	18-1-S3	6.5	<100	<100	<1	12	0.004		0.0004		0.0004	0.0007	
810735	18-1-S5	11.5	<100	<100	<1	6	0.004		0.0003		0.0002	0.0008	
810739	18-1-S9	21.5	400	300	<1	7	0.002		0.0002			0.001	
810740	18-2-S1	1.5	400	300	<1	12	0.003		0.0004		0.002	0.001	
810742	18-2-S3	6.5	400	300	<1	10	0.004		0.0003		0.0002	0.0009	
811472	18-2-S5	11.5	400	300	<1	4	0.002		0.0004		0.0003	0.0008	
811476	18-2-S9	21	400	300	<1	8	0.002		0.0003	0.0002	0.0004	0.0007	
811477	18-3-S1	1.5	400	300	<1	10	0.002		0.0002	0.0003	0.0006	0.0012	
811479	18-3-S3	6.5	400	300	<1	7	0.003		0.0003		0.0005		
811481	18-3-S5	11.5	400	300	<1	8	0.004		0.0005		0.0003	0.0008	
811485	18-3-S9	21	400	300	<1	7	0.003		0.0004		0.0005	0.001	
811486	18-4-S1	1.5	100	<100	<1	9	0.003		0.0005		0.0003	0.0009	
811488	18-4-S3	6.5	<100	<100	<1	8	0.002		0.0004		0.0003	0.0009	
811490	18-4-S5	11.5	<100	<100	<1	10	0.003		0.0004		0.0003	0.0019	
811494	18-4-S9	21.5	<100	<100	<1	7	0.001		0.0004		0.0003	0.001	

Note: Only those results reported at concentrations above detection are presented.

Site 18 soil boring ("S") sample analytical data are presented in Appendix H, Laboratory Report No. 8511-039, beginning on Page H-107.

Data are reported by Acurex sample number.

5. Groundwater Sampling Results

Groundwater samples were collected in two rounds (January and April 1986) from the following wells at Beale AFB:

- Twenty AeroVironment wells installed between September 1985 and January 1986. Well 01-01 was not sampled in January, but was sampled twice in April.

- Four wells installed by Radian Corporation at the Photo Wastewater Treatment Plant. Wells Nos. 2, 3, 4 were sampled in two rounds. Well No. 1 was sampled only once, in April 1986.

- Seven base production wells (Wells Nos. 1, 2, 3, 4, 5, 6 and 9). Well No. 1 was sampled only once, in January 1986.

Two sets of groundwater analytical data for each monitoring well provide an opportunity to assess the reproducibility of the monitoring program. Tables IV-17 through IV-47 give the analytical results. The locations of the wells are shown on Figures II-7 and I-3. Each table presents all data for each well from both rounds of sampling. Wells AV installed during this investigation are designated by a four-digit number. The first two digits indicate the site number (01 through 18) and the second two digits indicate the well number. For example, Well No. 02-01 is the unique number for the well installed at Site 2. The laboratory report number appears above each data column for reference to the analytical reports in Appendix H. The sample numbers are also given for each parameter. These are the numbers used as sample I.D. numbers in the laboratory reports. (See the introduction to Appendix H for more discussion.) Results from both rounds are presented side by side for comparison.

Groundwater samples were collected approximately three months apart during the same synoptic period, so time-induced variation is expected to be minimal. Well 01-01 was completed in late March 1986, and two samples were collected over a three-day period in mid-April, 1986. Radian Well No. 1 had an

TABLE IV-17. Groundwater sampling results for **Well 01-01** at Beale AFB, California.

	Round 1 4/14/86 8604-037[1]	Round 2 4/17/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	ND	0.2[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	11 (12)[f]
trans-1,2-DCE	1.1 (1.3)[f]	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	190 (110)[f]	58 (76)[f]
Dibromochloromethane[d]		
1,1,2-Trichloroethane[d]	ND	ND
cis-1,3-Dichloropropane[d]		
2-Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[c]	ND	ND
Tetrachloroethene[c]		
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	72	91
Analysis Date:	4/17/86	4/23/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	ND	ND
Ethylbenzene	ND	ND
Chlorobenzene	ND	ND
Xylenes	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	4/17/86	4/22/86
% Surrogate Recovery	97	84
Oil & Grease (mg/l)	2.1	8.5
Phenols (µg/l)	10	23
Metals[g] (µg/l)		
Barium	360	180

Footnotes:

1 — Analytical report number, refer to sample No. 906055 (601/602), 906056 (Oil & Grease), 906059 (Phenols), 906058 (Metals), beginning on page H-346 in Appendix H.

2 — Analytical report number, refer to sample No. 906207 (601/602), 906208 (Oil & Grease), [illegible] (Phenols), [illegible] (Metals), beginning on pages H-352, [illegible], [illegible], and [illegible], respectively, in Appendix H.

c — These compounds coelute.

d — These compounds coelute.

Chlorobenzene and meta-xylene

Ortho-xylene and para-xylene

e — Below normal laboratory background level.

f — Confirmed by GC/MS at level in parenthesis using EPA Method 624 and SP-1000 column.

g — As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND — Not detected.

TABLE IV-18. Groundwater sampling results for **Well 02-01** at Beale AFB, California.

	Round 1 1/7/86 8601-009[1]	Round 2 4/16/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.8[e]	ND
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1 2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1 1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a]		
1 1,2-Trichloroethane[a]	ND	ND
cis-1,3-Dichloropropane[a]		
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b]	ND	ND
Tetrachloroethene[b]		
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	113	78
Analysis Date:	1/9/86	4/23/86
602 Results (µg/l)		
Benzene	0.4	ND
Toluene	0.6	ND
Ethylbenzene	0.8	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/8/86	4/21/86
% Surrogate Recovery	160	84
Oil & Grease (mg/l)	0.5	0.9[h]
Phenols (µg/l)	35	NA
Metals[g] (µg/l)		
Barium	160	60
Base/Neutrals & Acids (µg/l)		
Phenol	2	ND

Footnotes:

1 - Acurex report number, refer to sample No. 810302 (601/602), 810303 (Oil & Grease), 810415 (Phenols), 810295 (Metals), and 810294 (BNA), beginning on page H-214 in Appendix H.

2 - Acurex report number, refer to sample No. 906152 (601/602), 906153 (Oil & Grease), 906154 (Metals), and 906155 (BNA), on pages H-350, 338, 320, and 325, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

h - Below concentration found in method blank

NA - Not analyzed

ND - Not detected

TABLE IV-19. Groundwater sampling results for **Well 03-01** at Beale AFB, California.

	Round 1 [illegible] 86 [illegible]	Round 2 [illegible] 86 [illegible]
601 Results (µg/l)		
[illegible]methane	ND	ND
[illegible]	ND	ND
D[illegible]rodifluorometh[illegible]ne	ND	ND
[illegible] chloride	ND	ND
[illegible]ethane	ND	ND
Methylene chloride	[illegible].8*	[illegible].8*
Tri[illegible]fluoromethane	ND	ND
[illegible]-DCE	ND	ND
[illegible]-DCA	ND	ND
trans-1,2-DCE	ND	[illegible]
[illegible]	ND	ND
[illegible]-DCA	ND	ND
[illegible]-TCA	[illegible]	ND
Carbon tetrachloride	ND	ND
Bro[illegible]methane	ND	ND
[illegible]	ND	ND
trans-1,3-Dichloropropene	ND	ND
TCE	ND	ND
Dibromochloromethane[1] [illegible]-Trichloroethane[1] [illegible]-1,3-Dichloropropene[1]	ND	ND
[illegible]	ND	ND
[illegible]	ND	ND
[illegible]	ND	ND
[illegible]		
[illegible]	ND	ND
[illegible]	ND	ND
Surrogate Recovery, %	[illegible]	[illegible]
Analysis Date	[illegible]	[illegible] 86
602 Results (µg/l)		
[illegible]	ND	ND
[illegible]		ND
[illegible]	[illegible]	ND
[illegible]	ND	ND
[illegible]	ND	ND
[illegible]	ND	ND
Analysis Date	[illegible] 86	[illegible] 86
% Surrogate Recovery	[illegible]	[illegible]
Oil & Grease (mg/l)	[illegible]	[illegible]
Petroleum, Hydrocarbons (µg/l)	[illegible]	[illegible]
Phenols (µg/l)	[illegible]	[illegible]
Lead (µg/l)	[illegible]	[illegible]

Footnotes:

- [illegible] report number, refer to sample No. 8[illegible]298 [illegible], 8[illegible]299 [illegible] & Grease, Pet. HC), 810300 (Phenols), and 8[illegible]30[illegible] (Lead), beginning on page H-214 in Appendix H.
- [illegible] report number, refer to sample No. 906069 [illegible] & Grease, Pet. HC) 906071 (Phenols), and 906072 (Lead) on pages H-346, 338, 305 and 319 in Appendix H.
- 1 - These compounds coelute
- [illegible] - These compounds coelute
  Chlorobenzene and meta-xylene
- [illegible] - Ortho-xylene and para-xylene
- * - Below normal laboratory background level
- [illegible] - Confirmed by GC/MS Method 624 (For [illegible])
- [illegible] - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.
- ND - Not detected

TABLE IV-20. Groundwater sampling results for **Well 03-02** at Beale AFB, California.

	Round 1 1/7/86 8601-009[1]	Round 2 4/15/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.8[e]	1.0[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	0.7
Dibromochloromethane[a]		
1,1,2-Trichloroethane[a]	ND	ND
cis-1,3-Dichloropropane[a]		
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b]	ND	ND
Tetrachloroethene[b]		
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	102	70
Analysis Date:	1/9/86	4/18/86
602 Results (µg/l)		
Benzene	ND[f]	ND
Toluene	0.8	ND
Ethylbenzene	0.3	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	0.4	ND
Analysis Date:	1/10/86	4/17/86
% Surrogate Recovery	101	102
Oil & Grease (mg/l)	0.8	0.7
Petroleum, Hydrocarbons (µg/l)	0.8	0.7
Phenols (µg/l)	<1	<1
Lead (µg/l)	<20	<20

Footnotes:

1 - Acurex report number, refer to sample No. 810894 (601/602), 810895 (Oil & Grease, Pet. HC), 810293 (Phenols), 810292 (Lead), beginning on page H-215 in Appendix H.

2 - Acurex report number, refer to sample No. 906073 (601/602), 906074 (Oil & Grease, Pet. HC), 906075 (Phenols), 906076 (Lead), on pages H-347, 338, 325, and 319, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Not confirmed by GC/MS Method 624 (GC gave value of 1.0 µg/l)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-21. Groundwater sampling results for **Well 03-03** at Beale AFB, California.

	Round 1 1/8/86 8601-013[1]	Round 2 4/14/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.8[e]	ND
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	0.2
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	108	69
Analysis Date:	1/9/86	4/17/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	0.2	ND
Ethylbenzene	0.3	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/10/86	4/17/86
% Surrogate Recovery	100	100
Oil & Grease (mg/l)	2.2	0.4[h]
Petroleum, Hydrocarbons (µg/l)	1.8	0.3[h]
Phenols (µg/l)	18	9
Lead (µg/l)	<20	<20

Footnotes:

1 - Acurex report number, refer to sample No. 810400 (601/602), 810401 (Oil & Grease, Pet. HC), 810403 (Phenols), 810402 (Lead), beginning on page H-234 in Appendix H.
2 - Acurex report number, refer to sample No. 906060 (601/602), 906061 (Oil & Grease, Pet. HC), 906062 (Phenols), 906063 (Lead), on pages H-346, 338, 305 and 319, respectively, in Appendix H.
a - These compounds coelute
b - These compounds coelute
c - Chlorobenzene and meta-xylene
d - Ortho-xylene and para-xylene
e - Below normal laboratory background level
f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)
g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.
h - Below concentration found in method bank
ND - Not detected

TABLE IV-22. Groundwater sampling results for **Well 03-04** at Beale AFB, California.

	Round 1 1/9/86 8601-026[1]	Round 2 4/14/86 8601-028[2]
601 Results (μg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	1.5[e]	ND
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a]		
1,1,2-Trichloroethane[a]	ND	ND
cis-1,3-Dichloropropane[a]		
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b]	ND	ND
Tetrachloroethene[b]		
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	95	85
Analysis Date:	1/13/86	4/17/86
602 Results (μg/l)		
Benzene	ND	ND
Toluene	0.2	ND
Ethylbenzene	0.8	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/13/86	4/17/86
% Surrogate Recovery	96	101
Oil & Grease (mg/l)	1.5	3.4
Petroleum, Hydrocarbons (μg/l)	1.2	2.4
Phenols (μg/l)	16	12
Lead (μg/l)	30	<20

Footnotes:

1 - Acurex report number, refer to sample No. 810424 (601/602), 810425 (Oil & Grease, Pet. HC), 810427 (Phenols), 810426 (Lead), beginning on page H-256 in Appendix H.

2 - Acurex report number, refer to sample No. 906064 (601/602), 906065 (Oil & Grease, Pet. HC), 906066 (Phenols), 906067 (Lead), on pages H-346, 338, 305 and 319, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-23. Groundwater sampling results for **Well 03-05** at Beale AFB, California.

	Round 1 1/7/86 8601-009[1]	Round 2 4/15/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.6[e]	2.0[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	0.8
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	88	76
Analysis Date:	1/9/86	4/18/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	0.3	ND
Ethylbenzene	0.6	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/8/86	4/17/86
% Surrogate Recovery	154	104
Oil & Grease (mg/l)	2.3	0.9
Petroleum, Hydrocarbons (µg/l)	1.4	0.5
Phenols (µg/l)	1	<1
Lead (µg/l)	<20	<20

Footnotes:

1 - Acurex report number, refer to sample No. 810288 (601/602), 810289 (Oil & Grease, Pet. HC), 810291 (Phenols), 810290 (Lead), beginning on page H-214 in Appendix H.

2 - Acurex report number, refer to sample No. 906079 (601/602), 906080 (Oil & Grease, Pet. HC), 906081 (Phenols), 906082 (Lead), on pages H-347, 338, 305 and 319, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-24. Groundwater sampling results for **Well 04-01** at Beale AFB, California.

	Round 1 1/6/86 8601-006[1]	Round 2 4/17/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.9[e]	1.3[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	0.08	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	0.2	0.1
Dibromochloromethane[a]		
1,1,2-Trichloroethane[a]	ND	ND
cis-1,3-Dichloropropane[a]		
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b]	ND	ND
Tetrachloroethene[b]		
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	106	60
Analysis Date:	1/9/86	4/24/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	3.0	ND
Ethylbenzene	1.4	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/8/86	4/23/86
% Surrogate Recovery	104	95
Oil & Grease (mg/l)	0.8	1.1
Phenols (µg/l)	<1	8
Metals[g] (µg/l)		
Barium	60	250

Footnotes:

1 - Acurex report number, refer to sample No. 810884 (601/602), 810886 (Oil & Grease), 810887 (Phenols), and 810885 (Metals), beginning on page H-200 in Appendix H.

2 - Acurex report number, refer to sample No. 906177 (601/602), 906178 (Oil & Grease), 906180 (Phenols), 906179 (Metals), on pages H-355, 338, 306 and 320, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-25. Groundwater sampling results for **Well 05-01** at Beale AFB, California.

	Round 1 1/6/86 8601-006[1]	Round 2 4/18/86 8604-037[2]
601 Results (µgl)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.5[e]	0.3[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	0.2	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	85	88
Analysis Date:	1/8/86	4/23/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	ND	ND
Ethylbenzene	11	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/8/86	4/22/86
% Surrogate Recovery	149	85
Oil & Grease (mg/l)	1.5	4.9
Phenols (µg/l)	<1	17

Footnotes:

1 - Acurex report number, refer to sample No. 810899 (601/602), 810900 (Oil & Grease), 810901 (Phenols), beginning on page H-200 in Appendix H

2 - Acurex report number, refer to sample No. 906115 (601/602), 906116 (Oil & Grease), 906117 (Phenols) on pages H-354, 338 and 306, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-26. Groundwater sampling results for **Well 06-01** at Beale AFB, California.

	Round 1 1/9/86 8601-026[1]	Round 2 4/15/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	1.2[e]	1.0[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	100	70
Analysis Date:	1/14/86	4/18/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	ND	ND
Ethylbenzene	0.4	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/13/86	4/17/86
% Surrogate Recovery	97	108
Oil & Grease (mg/l)	1.4	1.7
Phenols[g] (µg/l)	17	<1
Metals[g] (µg/l)		
Barium	120	130
Lead	40	<20
Pesticide/Herbicides (µg/l)		
Lindane	NA	0.01

Footnotes:

1 - Acurex report number, refer to sample No. 810488 (601/602), 810489 (Oil & Grease), 810490 (Metals), 810491 (Phenols), beginning on page H-258 in Appendix H.

2 - Acurex report number, refer to sample No. 906083 (601/602), 906084 (Oil & Grease), 906078 (Phenols), 906077 (Metals), 906037 (Pesticide/Herbicides), on pages H-348, 338, 305, 320, and 312/334 (509A/509B), respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

NA - Not analyzed

ND - Not detected

TABLE IV-27. Groundwater sampling results for **Well 06-02** at Beale AFB, California.

	Round 1 1/10/86 8601-028[1]	Round 2 4/15/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.5[e]	0.6[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	58	57
Analysis Date:	1/14/86	4/18/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	ND	ND
Ethylbenzene	0.6	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/14/86	4/17/86
% Surrogate Recovery	94	105
Oil & Grease (mg/l)	0.4	1.9
Phenols (µg/l)	9	<1
Metals[g] (µg/l)		
Barium	<50	50
Pesticide/Herbicides (µg/l)		
Lindane	NA	0.04

Footnotes:

1 - Acurex report number, refer to sample No. 810502 (601/602), 810503 (Oil & Grease), 810505 (Phenols), 810504 (Metals), beginning on page H-279 in Appendix H.

2 - Acurex report number, refer to sample No. 906038 (601/602), 906039 (Oil & Grease), 906041 (Phenols), 906040 (Metals), 906042 (Pesticide/Herbicides), on pages H-347, 338, 305, 320 and 312/334 (509A/509B), respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

NA - Not analyzed

ND - Not detected

TABLE IV-28. Groundwater sampling results for **Well 08-01** at Beale AFB, California.

	Round 1 1/7/86 8601-009[1]	Round 2 4/17/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.9[e]	0.6[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	116	75
Analysis Date:	1/9/86	4/24/86
602 Results (µg/l)		
Benzene	0.2	ND
Toluene	2.6	ND
Ethylbenzene	0.5	ND
Chlorobenzene[c]	0.2	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	0.4	ND
Analysis Date:	1/10/86	4/22/86
% Surrogate Recovery	100	93
Oil & Grease (mg/l)	0.6	0.5
Petroleum, Hydrocarbons (µg/l)	0.4	0.5
Phenols (µg/l)	<1	14

Footnotes:

1 - Acurex report number, refer to sample No. 810891 (601/602), 810892 (Oil & Grease, Pet. HC), 810893 (Phenols), beginning on page H-215 in Appendix H.

2 - Acurex report number, refer to sample No. 906174 (601/602), 906175 (Oil & Grease, Pet. HC), 906176 (Phenols), on pages H-355, 338, and 306, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-29. Groundwater sampling results for **Well 10-01** at Beale AFB, California.

	Round 1 1/6/86 8601-006[1]	Round 2 4/16/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.6[e]	ND
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	0.3	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	87	89
Analysis Date:	1/8/86	4/23/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	2.4	ND
Ethylbenzene	1.7	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/8/86	4/21/86
% Surrogate Recovery	116	93
Oil & Grease (mg/l)	2.0	1.5
Petroleum, Hydrocarbons (µg/l)	0.9	1.3
Phenols (µg/l)	<1	8

Footnotes:

1 - Acurex report number, refer to sample No. 810896 (601/602), 810897 (Oil & Grease, Pet. HC), 810898 (Phenols), beginning on page H-200 in Appendix H.

2 - Acurex report number, refer to sample No. 906157 (601/602), 906158 (Oil & Grease, Pet. HC), 906159 (Phenols), on pages H-350, 338, and 305, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-30. Groundwater sampling results for **Well 11-01** at Beale AFB, California.

	Round 1 1/6/86 8601-006[1]	Round 2 4/16/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.6[e]	ND
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	0.4	ND
Dibromochloromethane[a]		
1,1,2-Trichloroethane[a]	ND	ND
cis-1,3-Dichloropropane[a]		
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b]	ND	ND
Tetrachloroethene[b]		
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	94	81
Analysis Date:	1/8/86	4/23/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	16[f]	ND
Ethylbenzene	0.9	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/8/86	4/21/86
% Surrogate Recovery	115	97
Oil & Grease (mg/l)	3.3	7.2
Phenols (µg/l)	< 1	6

Footnotes:

1 - Acurex report number, refer to sample No. 810888 (601/602), 810889 (Oil & Grease), 810890 (Phenols), beginning on page H-200 in Appendix H.

2 - Acurex report number, refer to sample No. 906160 (601/602), 906161 (Oil & Grease), 906162 (Phenols), on pages H-351, 338, and 305, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

ND-Not detected

TABLE IV-31. Groundwater sampling results for **Well 13-01** at Beale AFB, California.

	Round 1 [illegible]/86 8[illegible]-028[1]	Round 2 4/16/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.8[e]	0.8[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	0.5
Chloroform	0.16	0.4
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	0.4	26 (24)[f]
Dibromochloromethane[3] 1,1,2-Trichloroethane[3] cis-1,3-Dichloropropane[3]	ND	ND
2-Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[5] Tetrachloroethene[5]	ND	1.0
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	[illegible]	68
Analysis Date	[illegible]/86	4/21/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	0.2	ND
Ethylbenzene	0.8	ND
Chlorobenzene	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	
Analysis Date	[illegible]/86	4/21/86
% Surrogate Recovery	103	93
Oil & Grease (mg/l)	0.8	0.5[h]
Phenols (µg/l)	--	<1
Metals[g] (µg/l)		
Barium	<50	50
Silver	<[illegible]	<10
Pesticide/Herbicides (µg/l)		
2,4-D	ND	0.09

Footnotes:

1 - Acurex report number, refer to sample No. 810496 (601/602), 810497 (Oil & Grease), 810498 (Metals), 810499 (Phenols), beginning on page H-279 in Appendix H.

2 - Acurex report number, refer to sample No. 906127 (601/602), 906128 (Oil & Grease), 906131 (Phenols), 906129 (Metals), 906130 (Pesticide/Herbicides), on pages H-349, 338, 305, 325 and 313/334 (509A/509B), respectively, in Appendix H.

3 - These compounds coelute

c - These compounds coelute
Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS at level in parenthesis using EPA Method 624 and SP-1000 column.

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

h - Below concentration found in method blank

ND - Not detected

TABLE IV-32. Groundwater sampling results for **Well 13-02** at Beale AFB, California.

	Round 1 1/10/86, 8601-028[1]	Round 2 4/16/86, 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.7[e]	[illegible].3[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	3.8	[illegible]
Chloroform	0.35	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	106[f]	28 (29)[h]
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	3.7	[illegible]
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	84	75
Analysis Date:	1/14/86	[illegible]
602 Results (µg/l)		
Benzene	ND	ND
Toluene	ND	ND
Ethylbenzene	0.8	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/14/86	[illegible]
% Surrogate Recovery	99	[illegible]
Oil & Grease (mg/l)	1.2	[illegible]
Phenols (µg/l)	NA	[illegible]
Metals[g] (µg/l)		
Barium	< 50	[illegible]
Pesticide/Herbicides (µg/l)		
2,4-D	ND	[illegible]

Footnotes:

1 - Acurex report number, refer to sample No. 810508 (601/602), [illegible] (Oil & Grease), 810506 (Pesticide/Herbicides), 810509 (Metals), beginning on page H-280 in Appendix H.

2 - Acurex report number, refer to sample No. 906139 (601/602), 906140 (Oil & Grease), 906143 (Phenols), 906141 (Metals), 906142 (Pesticide/Herbicides), on pages H-349, 338, 305, 320, and 313/334 (509A/509B), respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

h - Confirmed by GC/MS at level in parenthesis using EPA Method 624 and SP-1000 column.

i - Below concentration found in method blank.

NA - Not analyzed

ND - Not detected

TABLE IV-33. Groundwater sampling results for **Well 15-01** at Beale AFB, [illegible].

	[illegible]	[illegible]
601 Results (µg/l)		
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Methylene chloride	[illegible]	[illegible]
[illegible]	ND	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Tetrachloroethane	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
% Surrogate Recovery	[illegible]	[illegible]
Analysis Date	[illegible]	[illegible]
602 Results (µg/l)		
Benzene	[illegible]	[illegible]
Toluene	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Xylenes	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Analysis Date	[illegible]	[illegible]
% Surrogate Recovery	[illegible]	[illegible]
Oil & Grease (mg/l)	[illegible]	[illegible]
Phenols (µg/l)	[illegible]	[illegible]
Metals[g] (µg/l)		
Barium	[illegible]	[illegible]
Pesticide/Herbicides (µg/l)		
Lindane	[illegible]	[illegible]

Footnotes:

- [illegible] - Acurex report number, refer to sample No. 8[illegible]28 (601, 602), 8[illegible] (Oil & Grease), 8[illegible]35 (Phenols), 8[illegible]464 (Metals), beginning on page H-2[illegible] in Appendix H.
- [illegible] - Acurex report number, refer to sample No. 906096 (601, 602), 906097 (Oil & Grease), 906099 (Phenols), 906098 (Metals), 906[illegible] (Pesticides), 906[illegible] (Herbicides), on pages H-348, 338, 3[illegible], 320, 3[illegible]3, and 334, respectively, in Appendix H.
- a - These compounds coelute
- b - These compounds coelute
- c Chlorobenzene and meta-xylene
- d Ortho-xylene and para-xylene
- e - Below normal laboratory background level
- f - Confirmed by GC/MS Method 624 (For PCA/PCE, [illegible])
- g As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.
- h Below concentration found in method blank
- NA - Not analyzed
- ND - Not detected

TABLE IV-34. Groundwater sampling results for **Well 15-02** at Beale AFB, California.

	Round 1 [illegible]/9/86 8601-026[1]	Round 2 4/15/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	[illegible].8[e]	1.5[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
2-Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	[illegible]	56
Analysis Date:	[illegible]3/86	4/18/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	[illegible]	ND
Ethylbenzene	[illegible].6	ND
Chlorobenzene	ND	ND
Xylenes[c]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	[illegible]3/86	4/18/86
% Surrogate Recovery	98	96
Oil & Grease (mg/l)	[illegible]	0.6
Phenols (µg/l)	[illegible]	6
Metals[g] (µg/l)		
Barium	[illegible]20	[illegible]20
Pesticide/Herbicides (µg/l)		
Lindane	--	0.06

Footnotes:

1. Acurex report number, refer to sample No. 810460 (601/602), 810461 (Oil & Grease), 810463 (Phenols), 810462 (Metals), beginning on page H-256 in Appendix H.
2. Acurex report number, refer to sample No. 906085 (601/602), 906086 (Oil & Grease), 906088 (Phenols), 906087 (Metals) 906089 (Pesticide/Herbicides), on pages H-348, 338, 305, 320 and 3[illegible]334 (509A/509B), respectively, in Appendix H.

a These compounds coelute

b These compounds coelute

c Chlorobenzene and meta-xylene

d Ortho-xylene and para-xylene

e [illegible] laboratory background level

f Confirmed by [illegible] MS Method 624 (For PCA, PCE, only PCE found)

g As, Ba, [illegible], Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown. NA-Not analyzed

ND Not detected

TABLE IV-35. Groundwater sampling results for **Well 15-03** at Beale AFB, California.

	Round 1 1/9/86 8601-026[1]	Round 2 4/15/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.7[e]	6.8[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	0.7
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
etrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	75	75
Analysis Date:	1/13/86	4/21/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	ND	ND
Ethylbenzene	0.6	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/13/86	4/18/86
% Surrogate Recovery	97	94
Oil & Grease (mg/l)	0.5	0.8
Phenols (µg/l)	20	<1
Metals[g] (µg/l)	ND	ND
Pesticide/Herbicides (µg/l)		
Lindane	NA	0.1

Footnotes:

1 - Acurex report number, refer to sample No. 810466 (601/602), 810467 (Oil & Grease), 810469 (Phenols), 810468 (Metals), beginning on page H-256 in Appendix H.

2 - Acurex report number, refer to sample No. 906091 (601/602), 906090 (Oil & Grease), 906092 (Metals), 906093 (Phenols), 906094 (Pesticide), 906059 (Herbicides), on pages H-348, 338, 320, 305, 313/334 (509A/509B), respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

NA - Not analyzed

ND - Not detected

TABLE IV-36. Groundwater sampling results for **Well 15-04** at Beale AFB, California.

	Round 1 1/9/86 8601-026[1]	Round 2 4/15/86 8604-037[2]
601 Results (μg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.6[e]	0.6[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	88	62
Analysis Date:	1/14/86	4/18/86
602 Results (μg/l)		
Benzene	ND	ND
Toluene	0.3	ND
Ethylbenzene	0.5	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/13/86	4/17/86
% Surrogate Recovery	94	104
Oil & Grease (mg/l)	0.8	1.3
Phenols (μg/l)	22	2[h]
Metals[g] (μg/l)		
Barium	<50	210
Pesticide/Herbicides (μg/l)		
Lindane	NA	0.12

Footnotes:

1 - Acurex report number, refer to sample No. 810484 (601/602), 810485 (Oil & Grease), 810487 (Phenols), 810486 (Metals), beginning on page H-258 in Appendix H.

2 - Acurex report number, refer to sample No. 906043 (601/602), 906044 (Oil & Grease), 906045 (Metals), 906046 (Phenols), 906047 (Pesticide/Herbicides), on pages H-347, 338, 320, 305, and 312/334 (509A/509B), respectively, in Appendix H.

a - These compounds coelute
b - These compounds coelute
c - Chlorobenzene and meta-xylene
d - Ortho-xylene and para-xylene
e - Below normal laboratory background level
f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)
g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.
h - Below concentration found in method blank
NA - Not analyzed
ND - Not detected

TABLE IV-37. Groundwater sampling results for **Radian Well No. 1** at Beale AFB, California.

	Round 1 Not Taken	Round 2 4/16/86 8604-037[1]
601 Results (µg/l)		
Chloromethane	--	ND
Bromomethane	--	ND
Dichlorodifluoromethane	--	ND
Vinyl chloride	--	ND
Chloroethane	--	ND
Methylene chloride	--	ND
Trichlorofluoromethane	--	ND
1,1-DCE	--	ND
1,1-DCA	--	ND
trans-1,2-DCE	--	ND
Chloroform	--	ND
1,2-DCA	--	ND
1,1,1-TCA	--	ND
Carbon tetrachloride	--	ND
Bromodichloromethane	--	ND
1,2-Dichloropropane	--	ND
trans-1,3-Dichloropropane	--	ND
TCE	--	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	--	ND
Chloroethylvinyl ether	--	ND
Bromoform	--	ND
Tetrachloroethane[b] Tetrachloroethene[b]	--	ND
Chlorobenzene	--	ND
Dichlorobenzenes	--	ND
Surrogate Recovery, %	--	80
Analysis Date:	--	4/23/86
602 Results (µg/l)		
Benzene	--	0.3
Toluene	--	ND
Ethylbenzene	--	ND
Chlorobenzene[c]	--	ND
Xylenes[d]	--	ND
Dichlorobenzenes	--	ND
Analysis Date:	--	4/21/86
% Surrogate Recovery	--	92
Oil & Grease (mg/l)	--	8.4
Phenols (µg/l)	--	NA
Metals[g] (µg/l)		
Barium	--	70
Chromium	--	80
Base/Neutrals & Acids (µg/l)		
Phenol	--	5.0

Footnotes:

1 - Acurex report number, refer to sample No. 906150 (601/602), 906251 (Oil & Grease), 906252 (Metals), 906151 (BNA), on pages H-350, 338, 320 and 325, respectively, in Appendix H.
a - These compounds coelute
b - These compounds coelute
c - Chlorobenzene and meta-xylene
d - Ortho-xylene and para-xylene
e - Below normal laboratory background level
f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)
g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.
ND - Not detected

TABLE IV-38. Groundwater sampling results for **Radian Well No. 2** at Beale AFB, California.

	Round 1 1/8/86 8601-013[1]	Round 2 4/17/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	4.0[e]	0.3[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a]		
1,1,2-Trichloroethane[a]	ND	ND
cis-1,3-Dichloropropane[a]		
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b]	ND	ND
Tetrachloroethene[b]		
Chlorobenzene	0.4	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	112	87
Analysis Date:	1/10/86	4/23/86
602 Results (µg/l)		
Benzene	0.9[f]	0.9 (1.0)[h]
Toluene	0.3	ND
Ethylbenzene	0.8	ND
Chlorobenzene[c]	0.4	ND
Xylenes[d]	0.4	ND
Dichlorobenzenes	1.8	ND
Analysis Date:	1/11/86	4/21/86
% Surrogate Recovery	118	55
Oil & Grease (mg/l)	0.9	4.3
Phenols (µg/l)	28	NA
Metals[g] (µg/l)		
Barium	120	<40
Base/Neutrals & Acids (µg/l)		
Phenol	3	ND

Footnotes:

1 - Acurex report number, refer to sample No. 810408 (601/602), 810409 (Oil & Grease), 810412 (Phenols), 810411 (Metals), 810410 (BNA), beginning on page H-234 in Appendix H.

2 - Acurex report number, refer to sample No. 906199 (601/602), 906200 (Oil & Grease), 906202 (Metals), 906201 (BNA), on pages H-356, 339, 320, and 325, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown. h-Confirmed by GC/MS at level in parenthesis using EPA Method 624 and SP-1000 column.

NA - Not analyzed

ND - Not detected

TABLE IV-39. Groundwater sampling results for **Radian Well No. 3** at Beale AFB, California.

	Round 1 1/8/86 8601-013[1]	Round 2 4/17/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	3.9[e]	0.5[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a]		
1,1,2-Trichloroethane[a]	ND	ND
cis-1,3-Dichloropropane[a]		
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b]	ND	ND
Tetrachloroethene[b]		
Chlorobenzene	0.4	
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	94	76
Analysis Date:	1/10/86	4/24/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	0.3	ND
Ethylbenzene	0.4	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/10/86	4/22/86
% Surrogate Recovery	98	92
Oil & Grease (mg/l)	1.8	2.8
Phenols (µg/l)	37	NA
Metals[g] (µg/l)		
Barium	<50	50
Base/Neutrals & Acids (µg/l)	ND	ND

Footnotes:

1 - Acurex report number, refer to sample No. 810404 (601/602), 810405 (Oil & Grease), 810414 (Phenols), 810407 (Metals), 810406 (BNA), beginning on page H-234 in Appendix H.

2 - Acurex report number, refer to sample No. 906203 (601/602), 906204 (Oil & Grease), 906212 (Metals), 906211 (BNA), on pages H-352, 339, 320, and 326, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

NA - Not analyzed

ND - Not detected

TABLE IV-40. Groundwater sampling results for **Radian Well No. 4** at Beale AFB, California.

	Round 1 1/7/86 8601-009[1]	Round 2 4/17/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.8[e]	0.3[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	78	55
Analysis Date:	1/9/86	4/24/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	0.7	ND
Ethylbenzene	0.7	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/8/86	4/24/86
% Surrogate Recovery	162	96
Oil & Grease (mg/l)	0.8	2.7
Phenols (µg/l)	100	NA
Metals[g] (µg/l)		
Barium	60	160
Silver	30	<10
Base/Neutrals & Acids (µg/l)	ND	ND

Footnotes:

1 - Acurex report number, refer to sample No. 810296 (601/602), 810297 (Oil & Grease), 810413 (Phenols), 810287 (Metals), 810286 (BNA), beginning on page H-214 in Appendix H.

2 - Acurex report number, refer to sample No. 906213 (601/602), 906214 (Oil & Grease), 906216 (Metals), 906215 (BNA), on pages H-352, 339, 320, and 326, respectively, in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

NA - Not analyzed

ND - Not detected

TABLE IV-41. Groundwater sampling results for **Base Production Well No.** 1 at Beale AFB, California.

	Round 1 1/8/86 8601-013[1]	Round 2 Not taken
601 Results (µg/l)		
Chloromethane	ND	--
Bromomethane	ND	--
Dichlorodifluoromethane	ND	--
Vinyl chloride	ND	--
Chloroethane	ND	--
Methylene chloride	0.9[e]	--
Trichlorofluoromethane	ND	--
1,1-DCE	ND	--
1,1-DCA	ND	--
trans-1,2-DCE	ND	--
Chloroform	ND	--
1,2-DCA	ND	--
1,1,1-TCA	ND	--
Carbon tetrachloride	ND	--
Bromodichloromethane	ND	--
1,2-Dichloropropane	ND	--
trans-1,3-Dichloropropane	ND	--
TCE	ND	--
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	--
Chloroethylvinyl ether	ND	--
Bromoform	ND	--
Tetrachloroethane[b] Tetrachloroethene[b]	ND	--
Chlorobenzene	ND	--
Dichlorobenzenes	ND	--
Surrogate Recovery, %	136	--
Analysis Date:	1/11/86	--
602 Results (µg/l)		
Benzene	ND	--
Toluene	0.2	--
Ethylbenzene	0.9	--
Chlorobenzene[c]	ND	--
Xylenes[d]	ND	--
Dichlorobenzenes	ND	--
Analysis Date:	1/13/86	--
% Surrogate Recovery	103	--
Oil & Grease (mg/l)	0.4	--
Phenols (µg/l)	40	--
Metals[g] (µg/l)	ND	--

Footnotes:

1 - Acurex report number, refer to sample No. 810478 (601/602), 810479 (Oil & Grease), 810480 (Metals), 810481 (Phenols), beginning on page H-236 in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-42. Groundwater sampling results for **Base Production Well No. 2** at Beale AFB, California.

	Round 1 1/8/86 8601-013[1]	Round 2 4/18/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	21 (51)[f]
Bromomethane	ND	16 (16)[f]
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	1.0[e]	0.2[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	0.6 (2.4)[f]
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	1.4 (2.9)[f]
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	1.1 (2.7)[f,h]
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	101	82
Analysis Date:	1/11/86	4/24/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	ND	ND
Ethylbenzene	0.6	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/11/86	4/22/86
% Surrogate Recovery	104	145
Oil & Grease (mg/l)	0.4	0.9
Phenols (µg/l)	33	37
Metals[g] (µg/l)		
Barium	<50	50

Footnotes:

1 - Acurex report number, refer to sample No. 810438 (601/602), 810439 (Oil & Grease), 810440 (Metals), 810441 (Phenols), beginning on page H-235 in Appendix H.

2 - Acurex report number, refer to sample No. BP2-G2 (All parameters) on pages H-353 (601/602), 339 (Oil and Grease), 320 (Metals) and 306 (Phenols), in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - *Chlorobenzene and meta-xylene*

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS at level in parenthesis using EPA Method 624 and SP-1000 column.

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

h - Dibromochloromethane confirmed by GC/MS.

ND - Not detected

TABLE IV-43. Groundwater sampling results for **Base Production Well No. 3** at Beale AFB, California.

	Round 1 1/8/86 8601-013[1]	Round 2 4/18/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.9[e]	1.6[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	0.03
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	119	68
Analysis Date:	1/11/86	4/24/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	ND	ND
Ethylbenzene	1.1	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/13/86	4/22/86
% Surrogate Recovery	105	104
Oil & Grease (mg/l)	0.2	1.4
Phenols (µg/l)	34	26
Metals[g] (µg/l)		
Barium	70	90

Footnotes:

1 - Acurex report number, refer to sample No. 810482 (601/602), 810483 (Oil & Grease), 810437 (Phenols), 810436 (Metals), beginning on page H-236 in Appendix H.

2 - Acurex report number, refer to sample No. BP3-G2 (All parameters), on pages H-353 (601/602), 339 (Oil & Grease), 320 (Metals) and 306 (Phenols) in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-44. Groundwater sampling results for **Base Production Well No. 4** at Beale AFB, California.

	Round 1 1/8/86 8601-013[1]	Round 2 4/18/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.6[e]	1.8[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	0.02
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a] 1,1,2-Trichloroethane[a] cis-1,3-Dichloropropane[a]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b] Tetrachloroethene[b]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	54	73
Analysis Date:	1/11/86	4/24/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	ND	ND
Ethylbenzene	0.6	ND
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	0.5	ND
Analysis Date:	1/11/86	4/24/86
% Surrogate Recovery	102	98
Oil & Grease (mg/l)	0.4	<0.1
Phenols (µg/l)	46	33
Metals[g] (µg/l)		
Silver	50	<10

Footnotes:

1 - Acurex report number, refer to sample No. 810442 (601/602), 810443 (Oil & Grease), 810444 (Metals), 810445 (Phenols), beginning on page H-235 in Appendix H.

2 - Acurex report number, refer to sample No. BP4-G2 (All parameters), on pages H-353 (601/602), 339 (Oil & Grease), 320 (Metals), and 306 (Phenols) in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-45. Groundwater sampling results for **Base Production Well No. 5** at Beale AFB, California.

	Round 1 [illegible]/8/86 [illegible][1]	Round 2 4/18/86 8604-037[2]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	[illegible][e]	ND
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[3] 1,1,2-Trichloroethane[3] cis-1,3-Dichloropropane[3]	ND	ND
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[5] Tetrachloroethene[5]	ND	ND
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	75	79
Analysis Date:	[illegible]/13/86	4/24/86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	ND	ND
Ethylbenzene	0.5	0.9
Chlorobenzene[6]	ND	ND
Xylenes[7]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	[illegible]/11/86	4/24/86
% Surrogate Recovery	103	101
Oil & Grease (mg/l)	0.2	<0.1
Phenols (µg/l)	5	31
Metals[8] (µg/l)		
Lead	30	<20

Footnotes:

1 - Acurex report number, refer to sample No. 810446 (601/602), 810447 (Oil & Grease), 810448 (Metals), 810449 (Phenols), beginning on page H-235 in Appendix H.

2 - Acurex report number, refer to sample No. BP5-G2 (All parameters), on pages H-354 (601/602), 339 (Oil & Grease), 320 (Metals), and 306 (Phenols) in Appendix H.

3 - These compounds coelute

5 - These compounds coelute

6 - Chlorobenzene and meta-xylene

7 - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

8 - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-46. Groundwater sampling results for **Base Production Well No. 6** at Beale AFB, California.

	Round 1 [illegible]	Round 2 [illegible]
601 Results (µg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	[illegible][e]	ND
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	ND
Dibromochloromethane[a]		
1,1,2-Trichloroethane[a]	ND	ND
cis-1,3-Dichloropropane[a]		
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b]	ND	ND
Tetrachloroethene[b]		
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	[illegible]	79
Analysis Date:	[illegible] 11 86	[illegible] 24 86
602 Results (µg/l)		
Benzene	ND	ND
Toluene	ND	ND
Etnylbenzene	0.4	0.9
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	[illegible]/11/86	[illegible] 24 86
% Surrogate Recovery	103	[illegible]8
Oil & Grease (mg/l)	0.4	<[illegible]
Phenols (µg/l)	9	25
Metals[g] (µg/l)		
Barium	80	<40
Selenium	<10	30

Footnotes:

1 - Acurex report number, refer to sample No. 810450 (601/602), 810451 (Oil & Grease), 810452 (Metals), 810453 (Phenols), beginning on page H-236 in Appendix H.

2 - Acurex report number, refer to sample No. BP6-G2 (All parameters), on pages H-354 (601/602), 339 (Oil & Grease), 320 (Metals), and 306 (Phenols), in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

TABLE IV-47. Groundwater sampling results for **Base Production Well No. 9** at Beale AFB, California.

	Round 1 3 86 360[illegible][1]	Round 2 [illegible] 8 86 3604-0[illegible][2]
601 Results (μg/l)		
Chloromethane	ND	ND
Bromomethane	ND	ND
Dichlorodifluoromethane	ND	ND
Vinyl chloride	ND	ND
Chloroethane	ND	ND
Methylene chloride	0.9[e]	0.1[e]
Trichlorofluoromethane	ND	ND
1,1-DCE	ND	ND
1,1-DCA	ND	ND
trans-1,2-DCE	ND	ND
Chloroform	ND	ND
1,2-DCA	ND	ND
1,1,1-TCA	ND	ND
Carbon tetrachloride	ND	ND
Bromodichloromethane	ND	ND
1,2-Dichloropropane	ND	ND
trans-1,3-Dichloropropane	ND	ND
TCE	ND	0.2
Dibromochloromethane[a]		
1,1,2-Trichloroethane[a]	ND	ND
cis-1,3-Dichloropropane[a]		
Chloroethylvinyl ether	ND	ND
Bromoform	ND	ND
Tetrachloroethane[b]	ND	ND
Tetrachloroethene[b]		
Chlorobenzene	ND	ND
Dichlorobenzenes	ND	ND
Surrogate Recovery, %	129	56
Analysis Date:	1/11/86	4/24/86
602 Results (μg/l)		
Benzene	ND	ND
Toluene	ND	ND
Ethylbenzene	0.4	0.9
Chlorobenzene[c]	ND	ND
Xylenes[d]	ND	ND
Dichlorobenzenes	ND	ND
Analysis Date:	1/11/86	4/24/86
% Surrogate Recovery	99	107
Oil & Grease (mg/l)	0.8	0.5
Phenols (μg/l)	80	27
Metals[g] (μg/l)		
Barium	70	<40

Footnotes:

1 - Acurex report number, refer to sample No. 810454 (601/602), 810455 (Oil & Grease), 810456 (Metals), 810457 (Phenols), beginning on pages H-236 in Appendix H.

2 - Acurex report number, refer to sample No. BP9-G2 (All parameters), on pages H-354 (601/602), 339 (Oil & Grease), 320 (Metals) and 306 (Phenols), in Appendix H.

a - These compounds coelute

b - These compounds coelute

c - Chlorobenzene and meta-xylene

d - Ortho-xylene and para-xylene

e - Below normal laboratory background level

f - Confirmed by GC/MS Method 624 (For PCA/PCE, only PCE found)

g - As, Ba, Cd, Cr, Pb, Hg, Se, Ag. Those metals with concentrations above detection limits are shown.

ND - Not detected

construction in the January so it was not sampled at that time. Base Production Well Nos. 7 and 9 have been closed for several years. The pumps have been removed from both wells so no samples were collected during either sampling round. Base Production Well No. 1 was out of service in April 1986 and no sample could be sampled. Figures IV-20, IV-21 and IV-22 show the location of wells at Sites 4, 6 and 15, respectively. Wells at other sites have been shown on previous figures.

The majority of wells sampled at Beale had no significant concentrations of the chemicals for which they were analyzed and thus provided no basis for comparing results from the two rounds. Most samples showed low levels of methylene chloride or ethylbenzene in EPA 601 and 602 analyses. This is considered laboratory-induced contamination and was verified by the detection of these compounds in field and laboratory blanks at levels equaling or exceeding those found in samples. Table IV-48 summarizes the results of field blank analyses. Methylene chloride was more ubiquitous in groundwater samples than ethylbenzene; the latter was not reported present in field blanks. Ethylbenzene was an analytical contaminant that showed up sporadically in samples and laboratory blanks on a batch-by-batch basis.

Toluene was detected in many of the samples taken during Round 1 at concentrations as high as 16 µg/l. This compound was found to be a field contaminant resulting from a particular brand of electrical tape used in the well purging process. Electrical tape was used at 10-foot intervals to secure the wiring for the submersible pump to the discharge line. The tape was placed so that it was not under water, but some water cascaded down the discharge pipe as the pump was removed from each hole and came into contact with the tape. The contamination potential of this tape/water contact was confirmed through analysis of a VOC sample prepared by placing a piece of electrical tape in organic-free water. The sample contained a significant level of toluene (2500 µg/l). Different brands of tape were found to contribute different amounts of toluene to water, and the fact that several different brands of tape were used during the Round 1 sampling program may explain why the toluene results varied greatly. During the second sampling round, no electrical tape was used, and toluene was not detected

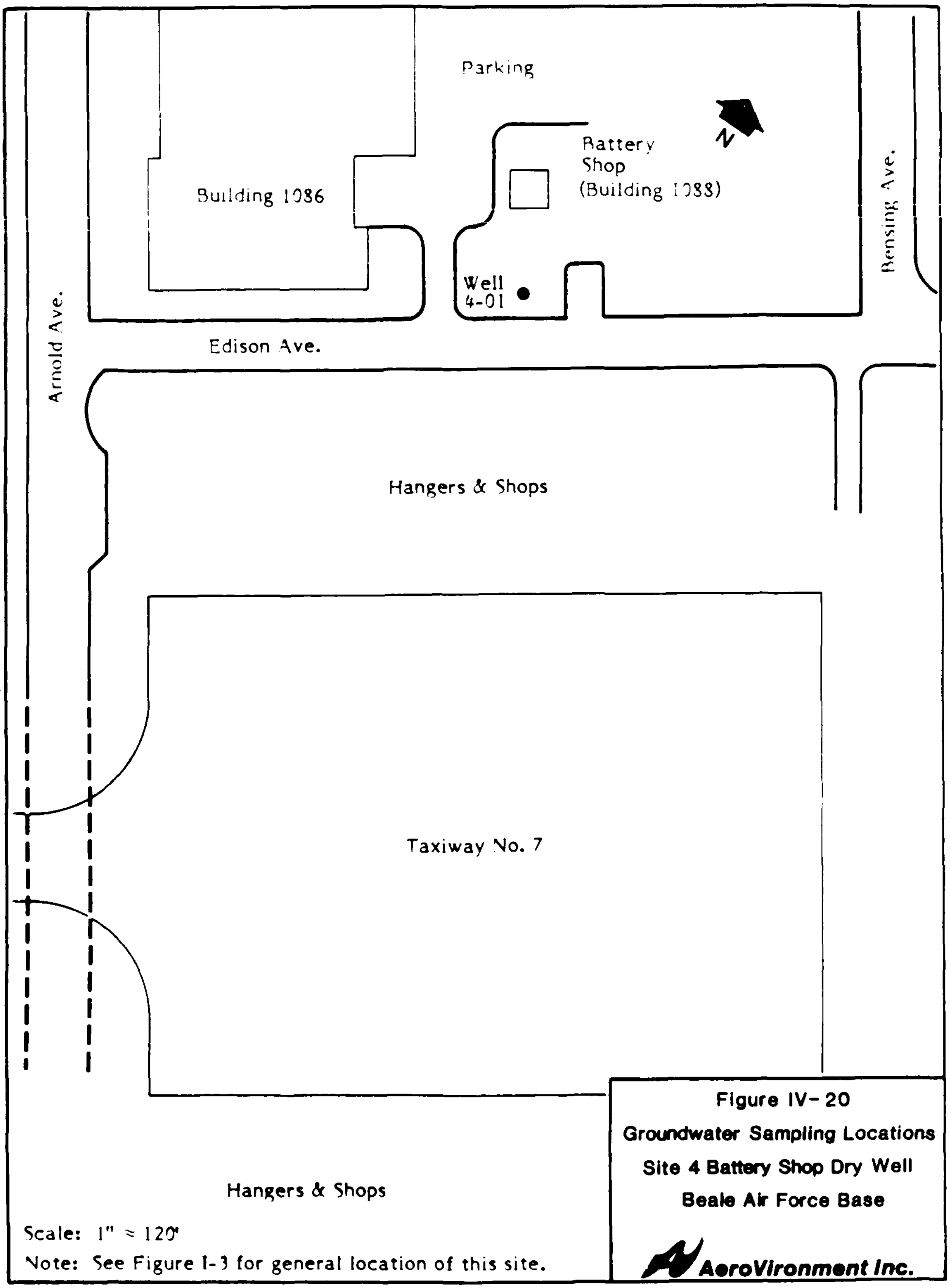
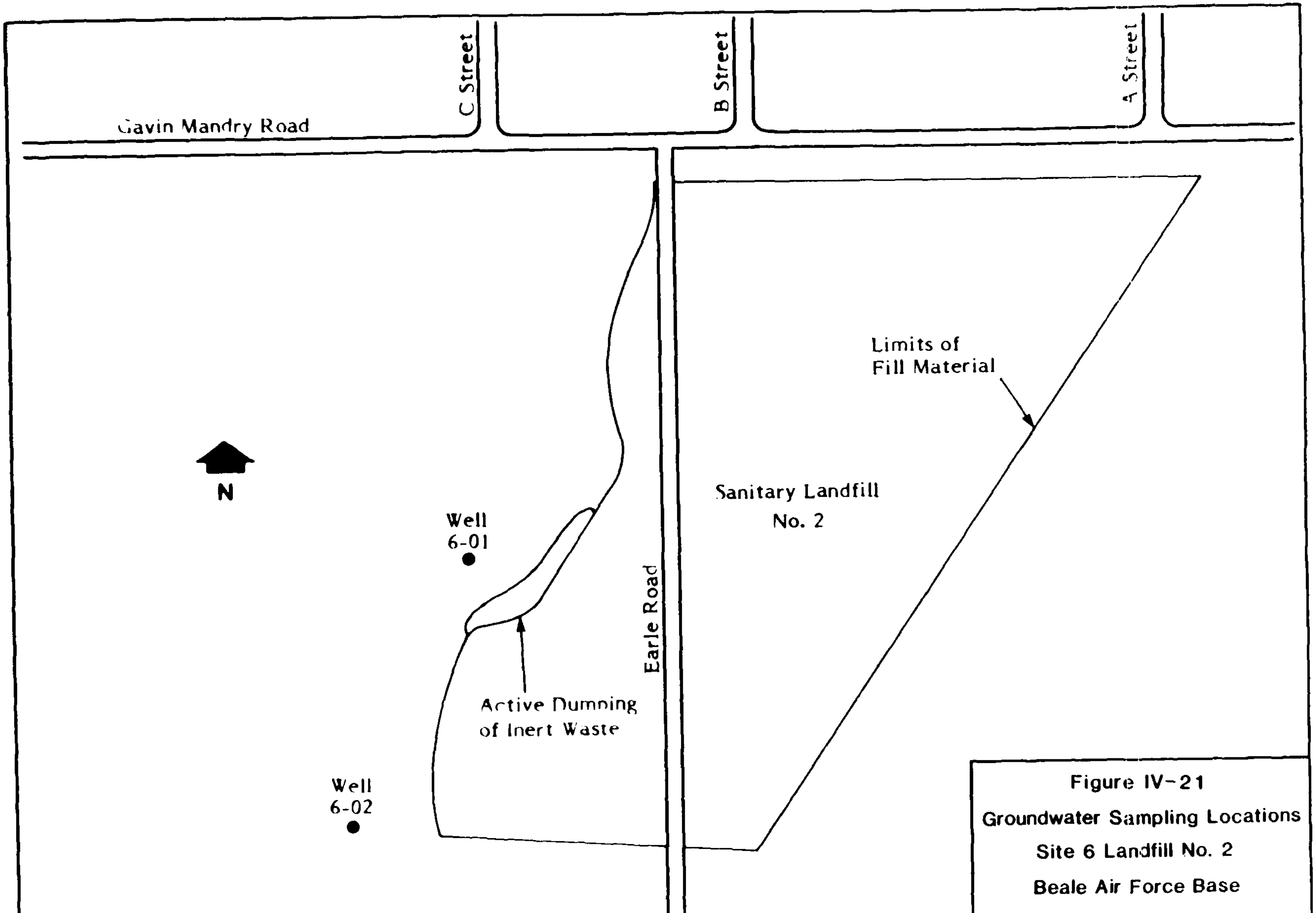


Figure IV-20
Groundwater Sampling Locations
Site 4 Battery Shop Dry Well
Beale Air Force Base

AeroVironment Inc.



Scale: 1" - 120'
Note: See Figure I-3 for general location of this site.

Figure IV-21
Groundwater Sampling Locations
Site 6 Landfill No. 2
Beale Air Force Base
AeroVironment Inc.

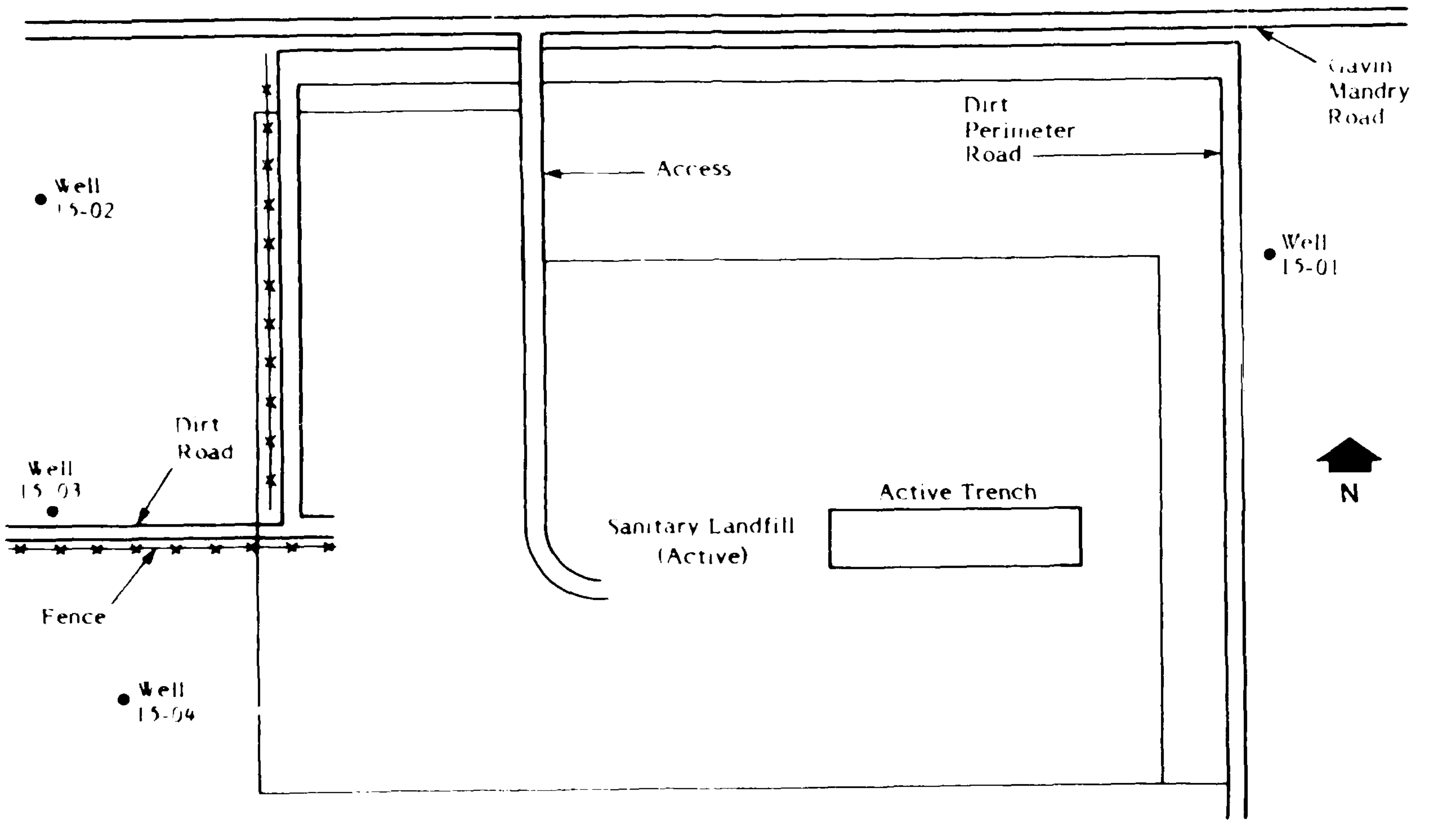


Figure IV-22
Groundwater Sampling Locations
Site 15 Landfill No. 3
Beale Air Force Base

AeroVironment Inc.

Scale: 1" = 120'

Note: See Figure I-3 for general location of this site.

TABLE IV-48. Summary of Field Blank Contamination.

Analyte	Maximum Concentration Found in Field Blank	Detection Limit	Units
Methylene Chloride	2.3	0.2	µg/l
Chloroform	0.8	0.05	µg/l
1,1,1-Trichloroethene	0.45	0.03	µg/l
TCE	0.5	0.1	ug/l
Ethylbenzene	0.7	0.2	ug/l
Oil and Grease	3.6	0.1	ug/l
Total Phenolics	17	1.0	µg/l
Barium	50	50	µg/l
Silver	30	10	µg/l
Bis(2-Ethylhexyl)Phthalate	14	2	µg/l
Phenol	4	2	µg/l

in any of the samples from this round. As a result, all toluene results are considered to be field-induced contamination.

All wells showed detectable levels of oil and grease (O&G). Precision was poor for the field O&G QA/QC data, and comparison of inter-round O&G results also showed poor correlation. Monitoring Well 01-01, sampled in two rounds three days apart, showed O&G values of 2.1 mg/l and 8.5 mg/l. O&G was detected in-field blanks and laboratory blanks, indicating laboratory-induced and possible field-induced contamination. As a result, the validity of the data cannot be confirmed and none of the O&G concentrations are considered significant. No regulatory standards for this parameter in groundwater exist.

Total recoverable phenol was found in most of the groundwater samples. However, the data did not correlate well between sampling rounds, and this difference is probably attributable to laboratory and/or sampling error and may not represent time-dependent changes in groundwater quality. Quality control data also indicate very poor intra-round precision for this method, as well as high background (field blank results were 9 and 17 µg/l for total phenols). Based on this information, wells for which total phenolics levels exceeded 20 µg/l for both first round and second round samples were considered to be significantly elevated above background. Base Production Wells Nos. 2, 3, 4, and 9 met this criterion. Relatively high levels of total phenolics were also detected in Well 02-01 and Radian Wells Nos. 2, 3, and 4, but two data sets for this parameter are not available for inter-round comparison. However, these four wells (Well 02-01, Radian Wells Nos. 2, 3, 4) were also analyzed for acid-extractable priority pollutants (EPA 625), which includes speciation of eleven phenolic compounds. No direct correlation of phenolic compounds was observed between the two analytical methods. Further discussion of this parameter along with quality assurance/quality control results for the sampling programs is included in Section III. E.

Analytical results from this sampling program show that four of the wells AV installed, representing three sites at Beale AFB, are contaminated with pollutant levels meeting or exceeding California Department of Health Services (DOHS) action levels. These are:

- Site 1 (West Drainage) Well 01-01, TCE contamination

- Site 2 (Injection Wells Nos. 1 and 2) Well 02-01, phenol contamination (one round only)

- Site 13 (Landfill 1) Wells 13-01 and 13-02, TCE contamination

In addition, samples show that three wells installed by Radian Corporation at the Photo Wastewater Treatment Plant to fulfill RCRA groundwater-monitoring requirements are contaminated at levels meeting or exceeding DOHS action levels. These are:

- Radian Well No. 1, phenol (one round only) and chromium (one round only) contamination

- Radian Well No. 2, benzene (both rounds) and phenol (one round only) contamination

For this investigation, the criteria for establishing the significance of analytical findings must take into account the following factors:

- The level of quantification (LOQ) for the analyte of interest, which is typically calculated as five to ten times the method's detection limit.

- The reproducibility of the measurements, both within sampling rounds and between rounds.

- The DOHS action levels for applicable parameters. Parameters for which action levels are not specified are assessed using other accepted water quality standards and available toxicity data.

In determining whether a finding is significant, after the data have been reviewed for validity (laboratory and field Quality Assurance/Quality

Control evaluation), the first step is to determine whether a DOHS action level has been established for the parameter. DOHS action levels and other water criteria are presented in Table IV-49. In some cases, the action level is below the LOQ for a given parameter. This situation occurs for the following parameters detected at Beale AFB:

- Benzene. The action level for benzene is 0.7 µg/l, and the LOQ is a minimum of 1.0 µg/l using EPA Method 602. Benzene was detected at 0.9 µg/l in samples from both rounds at Radian Well No. 2.

- Phenol. The action level for phenol is 1.0 µg/l, and the LOQ is a minimum of 10 µg/l (five times the minimum detection limit of 2 µg/l) using EPA Method 625. Results from EPA Method 420.1, which determines the presence of total phenolic compounds, are not applicable to the phenol action level because the method quantifies all phenolic compounds, not exclusively phenol.

- Selenium, Silver. These elements were detected at or below the LOQ in two base production wells at levels meeting or exceeding federal primary drinking water standards.

In several instances, analytical results were above action levels, but not reproducible between rounds. These are:

o Site 13, Landfill No. 1

  For the first sampling round, TCE was found in Well 13-02 at a concentration of 106 µg/l, but was only detected at 0.4 µg/l in Well 13-01. Second round TCE results were 26 µg/l for Well 13-02 and 28 µg/l for Well No. 13-01. This large variance may be caused by a number of factors: sampling error, analytical error, time-dependent changes in groundwater chemistry between sampling rounds, or the

TABLE IV-58. Action Levels Recommended by the California Department of Health Services, December 1986

Chemical	Action Level parts per billion (ppb)
Pesticides	
Chlorinated Hydrocarbon	
Aldrin	Limit of Quantification (0.05)
a-Benzene Hexachloride (a-BHC)	0.70
b-Benzene Hexachloride (b-BHC)	0.30
Chlordane	0.055
Dieldrin	Limit of Quantification (0.05)
Heptachlor	0.02
Heptachlor Epoxide	0.10
Pentachlorophenol	30.00
Organophosphate	
Dimethoate	140.00
Diazinon	14.00
Ethion	35.00
Malathion	160.00
Methyl Parathion	30.00
Parathion	30.00
Trithion	7.00
Carbamate	
Aldicarb	10.00
Baygon	90.00
Carbaryl	60.00
Phthalamide	
Captan	350.00
Amides	
Diphenamide	40.00
Fumigants	
Dibromochloropropane	1.00
1,2-Dichloropropane	10.00
Ethylene Dibromide	Limit of Quantification (0.02)
Chloropicrin	50.00 (37.0)*
Miscellaneous	
Terrachlor (Pentachloronitrobenzene)	0.90

*Taste and Odor Threshold

TABLE IV-58. (con't)

Chemical	Action Level parts per billion (ppb)
Herbicides	
CIPC	350.0
(isopropyl N (3-chlorophenyl carbamate)	
Bolero	10.0 (Tentative)
(thiobencarb)	1.0*
Ordram	20.0
(Molinate)	
Glyphosate	500.0
Atrazine	15.0
Simazine	150.0
Bentazon	8.0
(Basagran)	
Purgeable Halocarbons	
Carbon Tetrachloride	5.00
1,2-Dichloroethane	1.00
1,1-Dichloroethylene	6.00
Methylene Chloride	40.00
Tetrachloroethylene	4.00
1,1,1-Trichloroethane	200.00
Trichloroethylene	5.00
Vinyl Chloride	2.00
Cis-1,2-Dichloroethylene	16.00
Trans-1,2-Dichloroethylene	16.00
1,1-Dichloroethane	20.00
1,1,2-Trichloroethane	100.00
Freon 11	3400.00
Freon 13	18,000.00
(Action Level for Cis and Trans 1,2-Dichloroethylene is either for a single isomer or for the sum of the 2 isomers)	
Purgeable Aromatics	
Benzene	0.70
Monochlorobenzene	30.00 (3)*
1,2-Dichlorobenzene	130.00 (10)*
1,3-Dichlorobenzene	130.00 (20)*
1,4-Dichlorobenzene	Limit of Quantification (0.5)
Ethylbenzene	680.00 (29)*
(Action Level for dichlorobenzene is either for a single isomer or for the sum of the 3 isomers)	

*Taste and Odor Threshold

TABLE IV-58. (con't)

Chemical	Action Level parts per billion (ppb)
Toluene	100.00
Ortho-Xylene	620.00
Para-Xylene	620.00
Meta-Xylene	620.00
(Action Level for Xylene is either for a single isomer or the sum of the 3 isomers)	
Phenols	
2,4-dimethylphenol	400.00*
Phenol	1.00* (for chlorinated systems)
Aldehydes	
Formaldehyde	30.00

*Taste and Odor Threshold

nature of the groundwater flow. There is no evidence of sampling error, as field QA data was very good for Site 13: blind field duplicates of the first round 13-01 sample and the second round 13-02 sample were 0.4/0.4 µg/l and 28/29 µg/l for TCE, respectively. Field blanks from both sampling rounds contained no detectable TCE. Laboratory QA data was also very good for Method 601.

Thus the groundwater data from Site 13 show that: TCE is present in Wells 13-02 and 13-01 at levels above the LOQ and DOHS action levels, but the magnitude of TCE groundwater contamination is impossible to assess without further sampling and analysis.

- Site 2, Injection Wells Nos. 1 and 2

  Phenol was detected in the first round sample from Well 02-01 using EPA Method 625, but was not detected in the second round sample. The level of phenol reported for the first round sample was at the 2 µg/l method detection limit. This level is well below the LOQ and indicates only that phenol was present; it should not be interpreted as an accurate quantification. Thus, the data are not conclusive in defining the extent of groundwater phenol contamination at Site 2.

- Radian Monitoring Well No. 2

  Phenol was detected in Radian Well No. 2 at a level of 3 µg/l for one sampling round only. As with Well 02-01, the levels of the contaminants detected in these wells are below the LOQ and therefore are not conclusive.

o Radian Monitoring Well No. 1

Chromium was detected in Radian Well No. 1 at 85 µg/l for the second round sample. The well was sampled only once, due to an obstruction in the well during Sampling Round 1, so reproducibility could not be determined. The chromium value was within quantifiable range, since the minimum LOQ is 50 µg/l. The federal primary drinking water standard for chromium is 50 µg/l (0.05 mg/l). Radian Corporation has also detected chromium in this well in the same concentration range (71 to 100 µg/l) (Radian, 1985). While current data indicate that chromium is present, further sampling and analysis will be required to determine the extent of chromium contamination in Radian Well No. 1. Phenol was also detected at 5 µg/l but, like the chromium finding, was not confirmed with two rounds of sampling.

o Base Production Wells Nos. 4 and 6

Silver was detected in Base Production Well No. 4 at the federal primary drinking water standard of 50 µg/l during the first round of sampling. The sample from the second round at Base Production Well No. 6 had a selenium concentration of 30 µg/l, which is above the federal standard of 10 µg/l. Since each element was detected in only one round at or below LOQs, these levels are not considered significant.

In summary, several wells sampled at Beale AFB as part of this investigation had levels of contaminants exceeding DOHS and federal standards for drinking water. However, due to lack of reproducibility or contaminant levels below the method LOQ, conclusions concerning the presence and extent of contamination cannot be drawn. Only the following results are considered significant (see page IV-99):

o Wells 13-01 and 13-02

Significant TCE contamination was found in Monitoring Wells 13-01 and 13-02, but cannot be quantified due to considerable inter-round variance. Continued monitoring is necessary to determine the extent of this contamination. PCE was also found in both wells at concentrations below the action level.

o Radian Well No. 1

The chromium contamination in Radian Well No. 1 was found to be above the primary drinking water standard. Previous sampling and analysis confirms the presence of chromium in this well. Previous investigations have suggested, due to the high pH encountered in the groundwater, that chromium in the hexavalent state may be leaching from surrounding sediments into the well (Radian, 1985).

o Radian Well No. 2

Benzene contamination above the state action level and near the LOQ was detected in both rounds of sampling at Radian Well No. 2. Continued monitoring of this well is recommended to define the extent of benzene contamination.

Results that cannot be verified due to [illegible] reproducibility and/or LOQ are:

o Well [illegible]2-01, Radian Wells Nos. 1 and 2

Phenol was detected at levels greater than the action levels, but less than the method's LOQ in Well No. [illegible]

Radian Wells Nos. 1 and 2. However, none of the findings were confirmed for both sampling rounds. Additional monitoring, using an analytical method with greater sensitivity (for example, EPA 604) is recommended to better define the extent of phenol contamination.

b. Base Production Wells Nos. 4 and 6

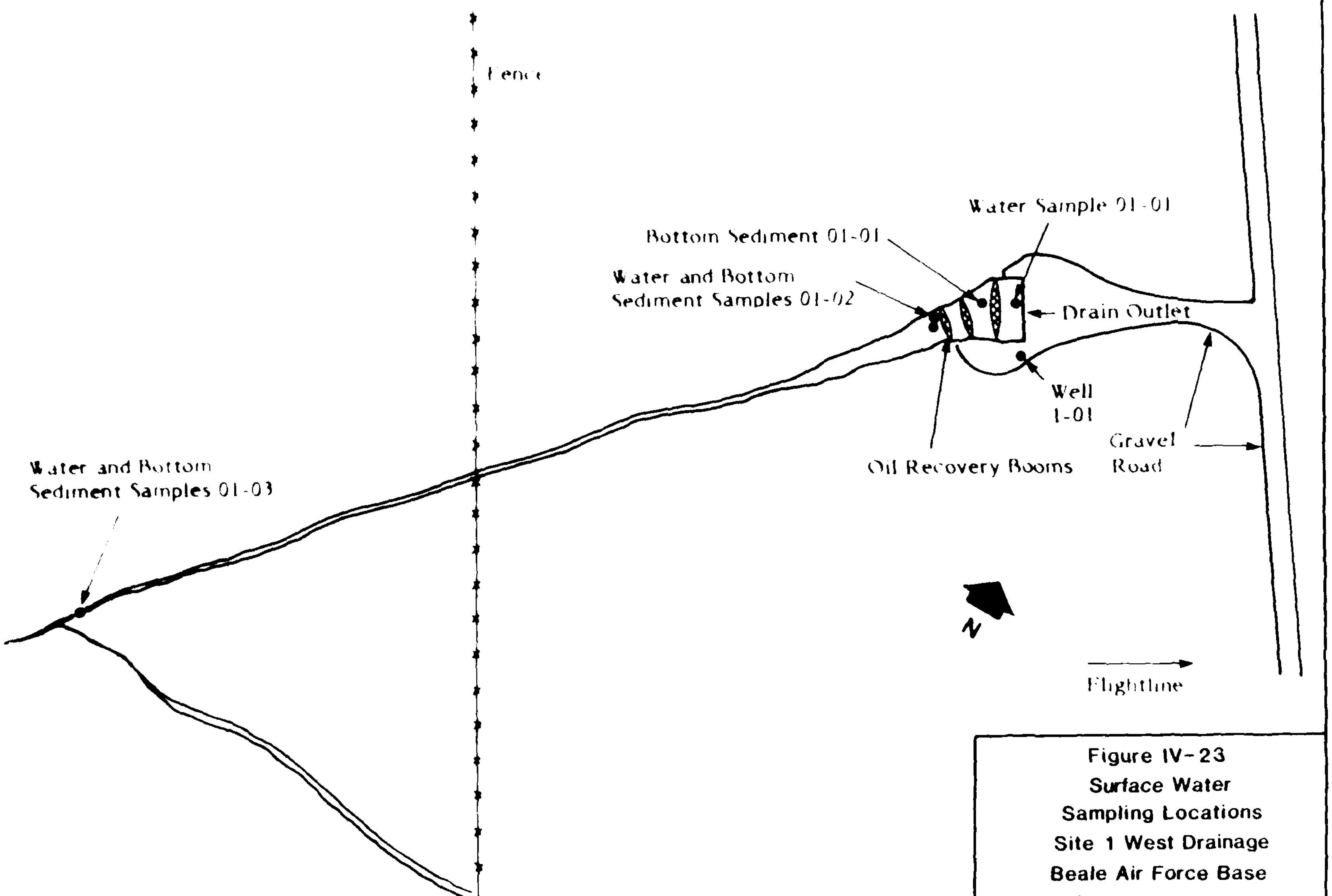
Silver and selenium levels at or above primary drinking water standards but below the LOQ were found in Base Production Wells Nos. 4 and 6. These findings are not considered significant, although further monitoring is recommended.

6. Surface Water Sampling Results

Site [illegible] -- West Drainage

The West Drainage was sampled at three locations: directly downstream of the culvert [illegible], directly downstream of the last of three oil [illegible] [illegible], and at a location approximately 150 yards downstream of the fence [illegible] [illegible] grazing stock [illegible] (see Figure IV-23). Tables IV-50 and IV-51 [illegible] the results. Floating oil with a [illegible] fuel-like odor was observed downstream of the culvert [illegible] during the second round of sampling. O&G for [illegible] was 8,000 µg/L within the boomed area and decreased rapidly with increasing distance downstream. No VOCs were detected above action levels, but low levels of chlorinated hydrocarbons were reported in the second round samples [illegible]. [illegible] surface water samples were not sampled for VOCs.

Bottom sediment samples were collected at each surface water sampling location at depths of [illegible] feet, with the exception of Sampling Location [illegible], where surface sediment was sampled. O&G results indicated significant hydrocarbon contamination in the bottom sediments; the highest level was



Scale: 1" 120'

Note: See Figure I-3 for general location of this site.

Figure IV-23
Surface Water
Sampling Locations
Site 1 West Drainage
Beale Air Force Base

AeroVironment Inc.

TABLE IV-50. Surface water sampling results from **Site 1**, West Drainage Ditch.

	Sample Number					
601 Results (ug/l)	[illegible]-W1 11/23/85 8511-032	1-1-W2** 4/17/86 8604-037	1-2-W1 11/23/85 8511-032	[illegible]-2-W2 4/17/86 8604-037	1-3-W1 11/23/85 8511-032	[illegible]
[illegible]ethane	NA	ND	NA	ND	NA	ND
[illegible]methane	NA	ND	NA	ND	NA	ND
[illegible]fluoromethane	NA	ND	NA	ND	NA	[illegible]
[illegible]ide	NA	ND	NA	ND	NA	ND
[illegible]ethane	NA	ND	NA	ND	NA	ND
[illegible] chloride	NA	<5[c]	NA	0.2*	NA	[illegible]*
[illegible]	NA	ND	NA	ND	NA	ND
[illegible]	NA	ND	NA	ND	NA	ND
[illegible]	NA	ND	NA	ND	NA	ND
trans-[illegible]	NA	ND	NA	ND	NA	ND
[illegible]	NA	ND	NA	ND	NA	ND
[illegible]	NA	ND	NA	ND	NA	ND
[illegible]	NA	ND	NA	ND	NA	ND
[illegible] tetrachloride	NA	ND	NA	ND	NA	ND
Brom[illegible]chloromethane	NA	ND	NA	ND	NA	ND
[illegible]propane	NA	ND	NA	ND	NA	ND
tra[illegible]propane	NA	ND	NA	ND	NA	ND
[illegible]	NA	ND	NA	[illegible](0.8)[d]	NA	ND
[illegible]romethane[a]	NA	ND	NA	ND	NA	ND
[illegible]ethane[a]	NA	ND	NA	ND	NA	ND
[illegible]propane[a]	NA					
[illegible] ether	NA	ND	NA	ND	NA	ND
[illegible]	NA	ND	NA	ND	NA	ND
[illegible]ethane[b]	NA	ND	NA	ND	NA	ND
[illegible]ethene[b]	NA					
[illegible]benzene	NA	ND	NA	ND	NA	ND
[illegible]benzenes	NA	ND	NA	ND	NA	[illegible]
[illegible] Recovery %	NA	[illegible]	NA	9[illegible]	NA	[illegible]
[illegible] Date	NA	4/24/86	NA	4/23/86	NA	4/2[illegible]/8[illegible]
602 Results (ug/l)						
[illegible]	NA	ND	NA	ND	NA	[illegible]
[illegible]	NA	ND	NA	ND	NA	[illegible]
[illegible]	NA	ND	NA	ND	NA	[illegible]
[illegible]benzene	NA	9.8	NA	ND	NA	[illegible]
[illegible]	NA	ND	NA	ND	NA	[illegible]
[illegible]	NA	ND	NA	ND	NA	[illegible]
[illegible] Date	NA	4/24/86	NA	4/2[illegible]/86	NA	[illegible]
[illegible]	NA	<8[illegible]	NA	[illegible]	NA	[illegible]
Metals (ug/l)	ND	ND	[illegible]	ND		
					[illegible]	[illegible]
Oil & Grease (mg/l)	[illegible]	[illegible]8,000	2[illegible]	[illegible]	[illegible]	
Phenols (ug/l)	[illegible]	22	[illegible]	[illegible]		

[illegible]

[illegible] background levels for methylene chloride are [illegible]5 ug
** [illegible] increased by a factor of ten [illegible] sample
[illegible] compounds coelute
[illegible] compounds coelute
[illegible] using EPA Method 624 and SP-1000 column gave [illegible] ug/L
[illegible] gave [illegible] ug/L
[illegible] MS at level in parenthesis using EPA Method 624
[illegible]
[illegible] analyzed
[illegible] sampled
[illegible] report No. [illegible] refer to sample No. 8,0828 (Metals), 8,0864 (Oil & Grease), 8,0865 (Phenols)
Matrix interference
[illegible] report No. [illegible] refer to sample No. 906,81 (601/602), 906,82 (Oil & Grease), 906,83 (Metals), 906,84 (Phenols)
[illegible] report No. [illegible] refer to sample No. 8,0829 (Metals), 8,0872 (Oil & Grease), 8,0873 (Phenols)
[illegible] report No. [illegible] refer to sample No. 906,85 (601/602), 906,88 (Phenols), 906,86 (Oil & Grease), 906,87 (Metals)
[illegible] report No. [illegible] refer to sample No. 8,0877 (Metals), 8,0877 (Metals), 8,0878 (Oil & Grease) and 8,0879 (Phenols)
[illegible] report No. [illegible] refer to sample No. 906,89 (601/602), 906,91 (Metals), 906192 (Phenols) and 906,90 (Oil & Grease)
[illegible]benzene and metaxylene
[illegible]xylene and para-xylene

[illegible] results are presented in Report [illegible] which begins on Page H-[illegible]63 in Appendix H.

[illegible] results are reported as follows:

Parameter	Report	Page in Appendix H
[illegible]	8604-037E	H-346
[illegible] Grease	8604-037F	H-338
Phenols	8604-037[illegible]	H-30[illegible]
Metals	8604-037B	H-3[illegible]9

TABLE IV-51.

Sediment Sampling Results

Site 1 - West Drainage Ditch

SITE 1: WEST DRAINAGE DITCH   Sampled 11/23/85 for Oil & Grease, Phenols, Metals and [illegible]

Acurex Report # 8511-052   UNITS ug/g

ACUREX #	BV SAMPLE #	DEPTH (FT)	O&G	PHENOLS	As	Ba	Cd	Cr	Pb	Hg	Se	Ag	Methylene Chloride	[illegible]	[illegible]	[illegible]	[illegible]	[illegible] Benzenes	[illegible]	Benzene	Toluene	Ethyl Benzene	[illegible] Benzene
810874	1-1-01	0.5	1800	[illegible]	4	54	[illegible]	20	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]				
810875	1-2-01	0.5	800	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			[illegible]		[illegible]				
810876	1-2-02	2.5	2100	[illegible]	[illegible]	66	[illegible]	[illegible]	44	.05	[illegible]	[illegible]	[illegible]	[illegible]				[illegible]	[illegible]				
[illegible]	1-3-01	0.5	33000	[illegible]	3.6	[illegible]	[illegible]	[illegible]	[illegible]	.05	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]		[illegible]	[illegible]		[illegible]		
[illegible]	1-3-02	2.5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]					[illegible]	[illegible]	[illegible]	[illegible]

Note: Only those results reported at concentrations above detection are presented.

Site 1 bottom sediment ("B") sample analytical data are presented in Appendix H, Laboratory Report No. 8511-052, beginning on Page H-169.

All data are reported by Acurex sample number.

Compound	TTLC (ug/g)
As	500
Ba	10,000
Cd	100
Cr	2,500
Pb	1,000
Hg	20
Se	100
Ag	500

[illegible], [illegible], from the [illegible] to 0.5-foot sediment sample farthest downstream ([illegible]). The vertical migration of the hydrocarbons seems to be greater [illegible]; Sample [illegible]-2-B1, collected at a depth of 2.5 feet, had [illegible] greater than the 0 to 0.5-foot sample from the same location, but the 2.5-foot Sample [illegible] collected downstream was clean. This apparent migration may be the result of highly permeable material that has been deposited at the exit of the drainage [illegible], or may result from deposition of new, relatively uncontaminated sediment over previously exposed, contaminated bottom material.

A significantly elevated lead concentration was detected in Bottom Sediment Sample [illegible]-3-B1, which corresponds to the elevated lead level in the water sample taken from the same downstream location. The lead appears to be in soluble form, since it is not deposited near the culvert, as would be expected if it were associated with particulate.

The creek was not flowing during either sampling round, and it became progressively shallower downstream of the inlet culvert until no standing water was observed a short distance past the downstream sampling location. Because there was little flow in the channel at the time of collection, no water sample could be collected at the base boundary to determine the potential for off-base contaminant migration.

Sites 2 – 12

No surface water samples.

Site 13 -- Landfill 1

Surface water and bottom sediment samples were collected from Hutchinson Creek at four locations adjacent to inactive Landfill 1 to determine whether the landfill is leaching pollutants into the creek (see Figure IV-24). Sample 13-01 was taken upstream of the landfill, and Samples 13-02, 13-03 and 13-04 were taken adjacent to and downstream of it. Bottom sediment samples were collected at each water sampling location from 0 to 0.5 feet in depth. Tables IV-52 and IV-53 give the results.

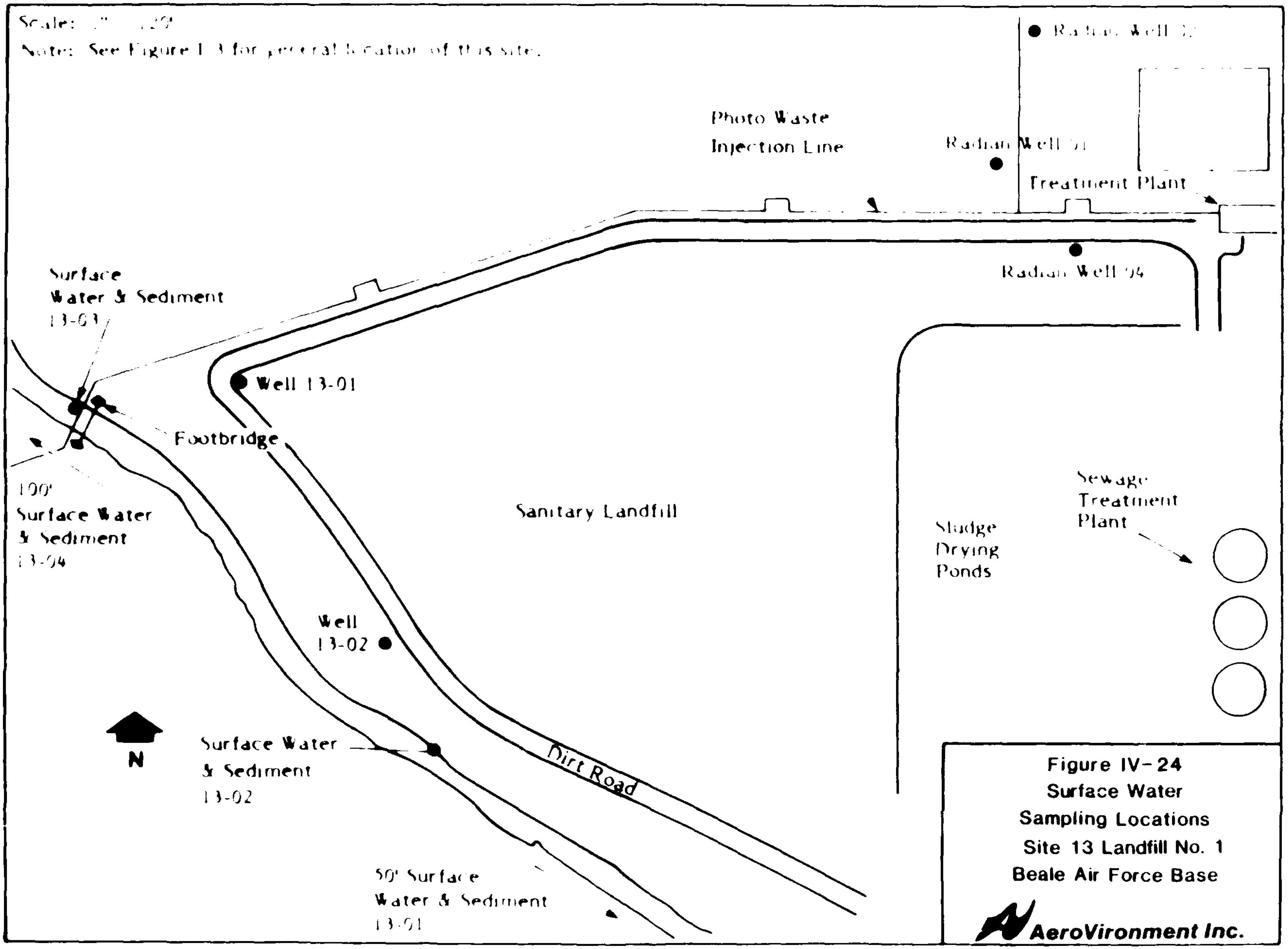


Figure IV-24
Surface Water
Sampling Locations
Site 13 Landfill No. 1
Beale Air Force Base

AeroVironment Inc.

TABLE IV-52. Surface water sampling results from **Site 13**, Landfill 1.

601 Results (µg/l)	13-1-W1 11/19/85 [illegible]	13-1-W2 4/16/86[1] 8604-037[3]	13-2-W1 11/19/86 8511-048[1]	13-2-W2 4/16/86 8604-037[5]	13-3-W1 11/19/85 8511-048[6]	13-3-W2 4/16/86 8604-037	13-4-W1 11/19/85 8511-048[3]	[illegible] 8604-037
[illegible]	ND	ND	ND	ND	ND	ND	ND	[illegible]
[illegible]	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]chloride	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]ethane	ND	ND	ND	ND	ND	ND	ND	ND
Methylene chloride	[illegible]*	ND	4.6*	ND	3.9*	ND	2.2*	[illegible]6*
[illegible]fluoromethane	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]DCE	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]DCE	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]	[illegible]	0.09	[illegible]	0.1	1.2	0.7	[illegible]	[illegible]
[illegible]A	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]	ND	ND	ND	ND	ND	ND	ND	ND
Carbon tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]bromomethane	[illegible]	ND	0.2	ND	0.2	ND	[illegible]	[illegible]
[illegible]propane	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]chloropropane	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]								
[illegible]methane[3]	ND	ND	ND	ND	ND	ND	ND	[illegible]
[illegible]ethane[3]	[illegible]04	ND	ND	ND	ND	ND	ND	ND
[illegible]propane[4]								
[illegible]ether	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]	ND	ND	ND	ND	ND	ND	ND	ND
Tetra[illegible]ethane[7]	ND	ND	ND	ND	ND	ND	ND	ND
Tetra[illegible]ethene								
[illegible]benzene	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]benzenes	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]	[illegible]	[illegible]	84	86	97	94	88	66
[illegible] date	[illegible]25/86	4/23/86	[illegible]25/85	4/23/86	11/25/85	4/23/86	[illegible]25/85	4/2[illegible]/86
602 Results (µg/l)								
[illegible]	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]	[illegible]	ND	[illegible]	ND	0.3	ND	[illegible]	ND
[illegible]	[illegible]	ND	[illegible]	ND	0.6	ND	0.8	ND
[illegible]	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]	ND	ND	ND	ND	ND	ND	ND	ND
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	96	[illegible]	[illegible]
[illegible]	[illegible]/86	[illegible]/86	[illegible]/86	[illegible]/86	[illegible]/86	[illegible]/86	[illegible]/86	[illegible]
Metals (µg/l)	[illegible]			ND		[illegible]		
[illegible]		[illegible]	ND					[illegible]
[illegible]		[illegible]	[illegible]				[illegible]	
Oil & Grease (mg/l)		[illegible]	[illegible]	[illegible]	20 [illegible]	[illegible]	[illegible]	[illegible]
Phenols (µg/l)	[illegible]	[illegible]		[illegible]8	[illegible]	[illegible]	[illegible]	[illegible]
Pesticides/Herbicides (µg/l)				[illegible]				[illegible]
[illegible]	[illegible]	[illegible]		[illegible]06	0[illegible]	[illegible]	[illegible]	[illegible]
[illegible]				[illegible]		[illegible]		[illegible]

* [illegible] methylene chloride are [illegible] µg/l.
[illegible] compounds [illegible]
[illegible] compounds [illegible]
[illegible]
[illegible] refer to sample No. [illegible] (Metals), [illegible] (Oil & Grease), [illegible] (Phenols), 810744 (601) [illegible] Pesticides/Herbicides.
[illegible] refer to sample No. 906248 (Metals), 906250 (Phenols), [illegible] (Oil & Grease), 906246 (601, 602) and 906249 (Pesticides/Herbicides).
[illegible] refer to sample No. [illegible] (Metals), [illegible] (Oil & Grease), [illegible] (Phenols), 810755 (601) and [illegible] Pesticides/Herbicides.
[illegible] refer to sample No. 906263 (Metals), [illegible] (Oil & Grease), 906265 (Phenols), 906264 (601, 602) and [illegible] (Pesticides/Herbicides).
[illegible] refer to sample No. [illegible] (Metals), [illegible] (Oil & Grease), [illegible] (Phenols), 810760 (601) and [illegible] Pesticides/Herbicides.
[illegible] refer to sample No. [illegible] (Metals), [illegible] (Phenols), [illegible] (Pesticides/Herbicides), [illegible] (601, 602) and [illegible] (Oil & Grease).
[illegible] refer to sample No. [illegible] (601), [illegible] Pesticide/Herbicides, [illegible] (Metals) and 810767 (Oil & Grease).
[illegible] refer to sample No. [illegible] (601, 602), [illegible] (Pesticides/Herbicides), [illegible] (Metals), [illegible] (Phenols) and [illegible] (Oil & Grease).
[illegible]
[illegible]

[illegible] results are presented in Report [illegible] beginning on Page [illegible] [illegible] samples were collected [illegible] Sample Nos. [illegible] and [illegible] beginning on Page [illegible] Appendix [illegible]

[illegible] results are reported as follows:

[illegible]	Report	Page in Appendix [illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

TABLE IV-53.

Sediment Sampling Results

Site 13 - Landfill No. 1

SITE 13 LANDFILL 1 Sampled [illegible]/85 for [illegible] & Grease, Metals, Phenols, 504 HAV and 8010/8020
Acurex Report # 8511-048 UNITS: ug/g

													8010				8020	
ACUREX #	HV SAMPLE #	DEPTH (FT)	O&G	PHENOLS	As	Ba	Cd	Cr	Pb	Hg	Se	Ag	Methylene Chloride	Chloroform	Dichloro-benzenes	1,1-DCE	Toluene	Ethyl Benzene
810[illegible]	13-1-B1	0.5	<100	<1	[illegible]3	5[illegible]	<0.6	1[illegible]	8	<.05	<0.2	4	0.002	0.0004				0.0006
810[illegible]	13-2-B1	0.5	<100	<1	14	35	<0.6	20	7	<.05	<0.2	1.2	0.004	0.0033				0.0007
810[illegible]	13-3-B1		<100	1	14	66	<0.4	[illegible]	13	0.1	<0.2	12	0.002		0.0006	0.0003	0.0002	0.0006
81[illegible]	13-4-B1	"	<100	2		44	<0.4	1	5	<.05	<0.2	1.6	.002	0.000[illegible]				0.000[illegible]

Note: Only those results reported at concentrations above detection are presented.

Site 13 bottom sediment ("B") sample analytical data are presented in Appendix H, Laboratory Report No. 8511-048, beginning on Page H-138.

All data are reported by Acurex sample number.

Compound	TTLC (μg/g)
As	500
Ba	10,000
Cd	100
Cr	2,500
Pb	1,000
Hg	20
Se	100
Ag	500

Low levels of the organochlorine pesticides gamma-BHC (Lindane) and Aldrin and the chlorophenoxy herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) were detected in the water samples. Lindane was found at levels above the LOQ in all but one sample from both sampling rounds and is therefore considered to be significant (0.04-0.11 µg/l). No action level is specified for Lindane. Aldrin was detected in all of the second round samples at concentrations near the method detection limit and well below the LOQ. The action level for Aldrin, which is 0.05 ug/l, was equaled or exceeded for each sample collected during the second round. No Aldrin was detected during the first round. The nonreproducibility between sampling rounds does not necessarily indicate sampling or analytical error, given the dynamic nature of surface water systems as opposed to groundwater. Aldrin and Lindane are relatively persistent and stable in the environment, though the probability that these compounds originate at Landfill 1 is remote, since the upstream sample was reported to contain both, and there is no significant increasing trend in the downstream samples. 2,4-D, a common herbicide, was detected in three samples at levels of 0.07 and 0.08 ug/l (below the LOQ). Although no action level is specified for 2,4-D, the primary drinking water standard is 100 ug/l. The levels of 2,4-D found are not considered to be significant evidence of contamination.

Volatile organic (VOC) samples collected from Site 13 during the first sampling round in November 1985 were not analyzed by EPA Method 602 within the specified holding time due to a laboratory instrument malfunction. VOC was resampled in January 1986 to provide a valid data set. No significant levels of VOCs were found in Site 13 surface water samples.

All bottom sediment samples were below background for the parameters analyzed. No further significant evidence of surface water contamination was found at Site 13.

Sites 14 - 16

No surface water samples taken.

o Site 17 -- Best Slough

One surface water sample was taken at Site 17, Best Slough (Figure IV-18), to evaluate potential contamination due to a suspected drum disposal area near the slough (see Table IV-54). A volatile organic sample collected during the first sampling round in November 1985 was not analyzed by EPA Method 602 within the specified holding time due to a laboratory instrument malfunction. Another volatile organic sample was taken and analyzed in January 1986 to provide a valid data set. No volatile organics were found.

B. Significance of Findings

1. Possible Contamination Pathways

A number of geologic and hydrologic factors affect the migration of contaminants from the surface or shallow subsurface into the water table. The first, and most obvious, is that many industrial areas on base are on flat terrain; therefore, runoff rates are low. This allows rain water, and potential spills, to be retained for longer periods in one area, giving time for infiltration to occur. Most of the upper soils are relatively permeable, but there is a well-defined hardpan zone under some areas of the base that will inhibit downward migration. In those areas where the hardpan layer has been breached (by landfill trenches, etc.) or does not exist, infiltration to the underlying strata may be fairly high.

If a spill does occur, the liquid will migrate downward through the unsaturated zone with some lateral spreading. The rate of this downward migration will depend on the soil type, the type of contamination, the volume of liquid involved, and the precipitation rate. The downward migration of the liquid will eventually be stopped by retention in the soils, an impermeable barrier, or the water table. If the migrating contaminant encounters a large enough volume of soil, all of it may become trapped in the soil's pore spaces and immobilized before it reaches the water table. If this is the case, the immediate problem of groundwater contamination may be averted. A further addition of more

TABLE IV-54. Surface water sampling results from Site 17, [illegible]

[illegible] Results [illegible]

contaminant or infiltrating rainfall may reactivate the plume and continue its downward or lateral migration.

If the contaminant encounters an impermeable barrier (such as hardpan), it will spread out along this layer in the down dip direction until it is eventually immobilized by soil retention. If the contaminant reaches the water table in sufficient quantities, degradation of the aquifer down gradient is inevitable.

The production zone for most wells on base begins at approximately 100 to 150 feet below the ground surface, in the water table aquifer. The strata above the production zone generally consists of alternating layers of sand, gravel, silt and clay of varying permeability. The rate of percolation to the production zone is higher in those areas where the overlying beds are predominantly gravel or sand and silt, rather than clay.

A number of pathways are possible for upper strata contamination to enter the production zone. The primary pathways are shown in Figure IV-25. The first is infiltration and leakage from the upper strata into the production zone through the confining layer. The source of the leakage is at an up gradient location. This is especially critical where the overlying strata are permeable due to gravel near the surface. A contributing factor to this pathway of pollutant travel into production wells is the placement of well screening in relatively shallow, permeable zones. In some of the production wells, perforation begins as shallow as 93 feet. This upper permeable zone would be the first stratum to be contaminated, and wells which tap these shallower zones in areas where contamination exists are likely to become contaminated.

A second contamination pathway is the vertical movement of pollutants from a contaminated shallow aquifer, down the annular space of a well, into lower aquifers. This is a common source of pollution in old wells and is related to past well construction practices where no seal or an inadequate seal was provided between the surface zones and the deeper zones from which water is drawn into the well. This situation can cause problems in two ways. If the well is active, the contaminants will be drawn down through the well's gravel pack and be

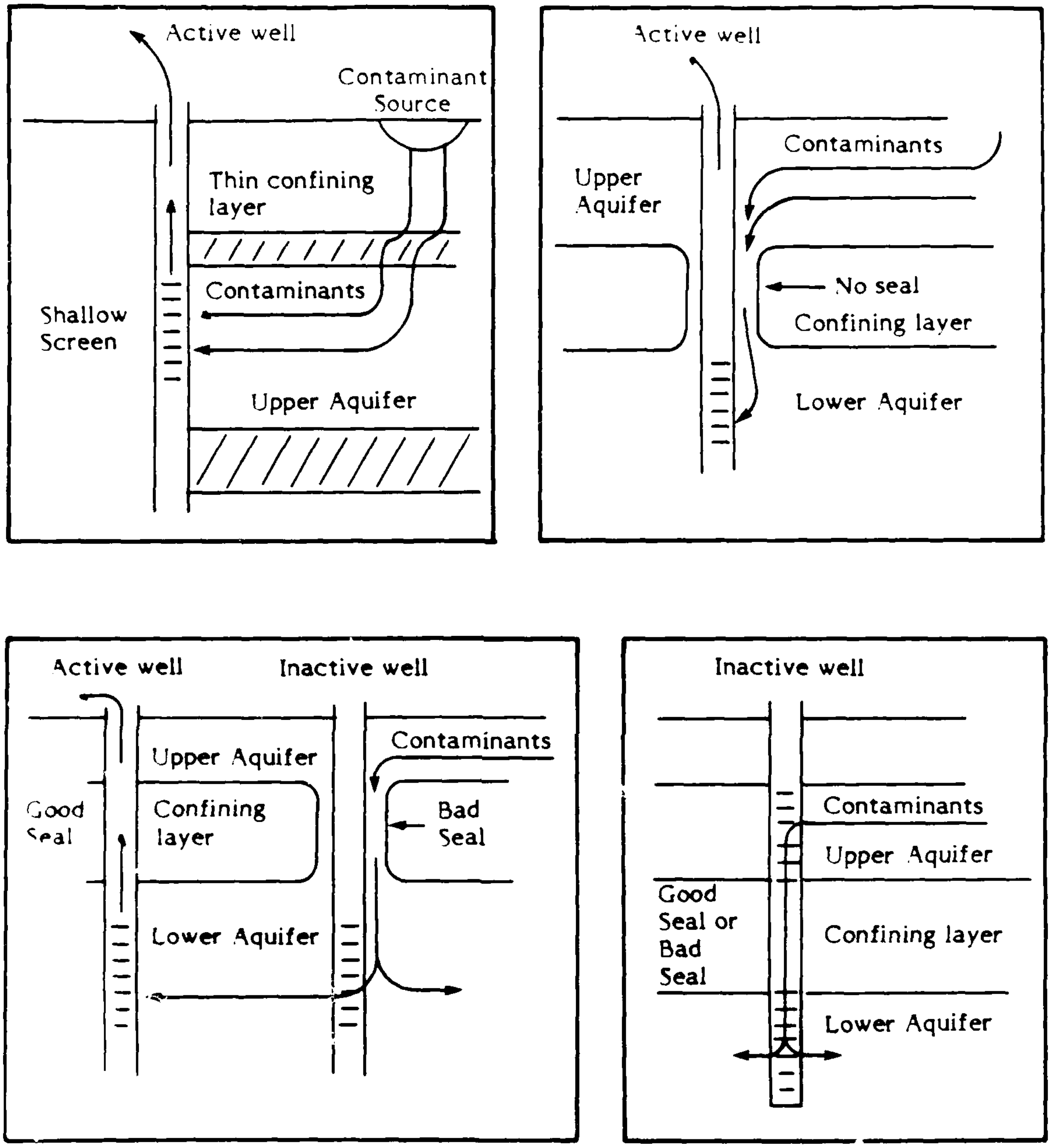


Figure IV-25

Possible Contamination Routes

Beale Air Force Base

AeroVironment Inc.

pumped up into the water supply. If the well is abandoned or not currently pumping, contaminants can flow down the gravel pack and begin to disperse into the aquifer. This contaminated aquifer water may be pumped into water supplies from the well that is providing the contaminant path or from other deep wells down gradient.

Another way for contaminants to spread to lower aquifers is through inactive wells which have screens in two or more aquifers. In such cases, water may enter the upper screen, flow down the inside of the well, and exit through a deeper screen into the aquifer.

The water table aquifer on base is found in either the Laguna Formation or in the transition zone between the Laguna and the underlying Mehrten Formation. Water percolates slowly through the Laguna Formation, which has much more clay and silt than the overlying gravels. Because contaminants travel slowly, they are more likely to sorb onto clay or silt particles, which would inhibit passage into the groundwater.

2. Site-Specific Findings

o <u>Site 1</u> -- West Drainage Area

The West Drainage System drains surface runoff from the flightline and the runway area. Runoff is carried through a culvert that runs under the flightline and discharges through a headwall located about 800 feet west of the main runway. The water flows into a natural ditch and channel that flows to natural depressions in the pasture lands further to the west. During heavy precipitation, water from the West Drainage flows off base. Because of historical problems with hydrocarbons flowing out of the West Drainage culvert, the civil engineering roads and grounds division has placed three oil-absorbent booms have been placed across the stream immediately downstream of the head wall.

Surface water and bottom sediment samples were collected in January and April 1986. Significant findings include apparent jet fuel floating on

the water surface upstream of the oil boom during the second sampling round. The oil and grease concentration of the second round upstream sample was 18,000 mg/l. Within 100 feet downstream of the oil booms, the surface water contamination dropped off dramatically; however, sediment samples were highly contaminated and there was visual evidence of substantial hydrocarbon content in the soil under the stream bed. Downstream surface sediments contained 33,000 μg/g of oil and grease and 410 μg/g of lead. Figure IV-26 shows the significant results from this site.

Between the first and second sample rounds, a groundwater monitoring well was installed near the headwall. The well was not installed prior to the first sampling round because weather conditions precluded equipment access to the site. Two samples were taken from this well, but they were both collected three days apart during the April sampling round. The groundwater beneath Site 1 contains trichloroethylene (TCE). TCE concentrations were found to be 100 and 58 μg/l in these two samples, well over the state action level of 5 μg/l. No other contaminants, including O&G, were found in this well (TCE was not found in the surface water). Figure IV-27 shows the significant findings for all wells sampled during this study.

Site 1 is generally upgradient from the base well field. Common well construction practice at the time the base production wells were installed was to gravel-pack the entire well from about 50 feet below ground surface to the total completed depth of the well. Individual water-bearing zones were not isolated from one another. Various base wells are perforated from as shallow as 93 feet below the land surface (BLS) to a maximum of 330 feet. The well at Site 1 is screened from 98 to 118 feet BLS. Groundwater flow in this area is controlled by a large pumping depression south and west of the base. Although no evidence of contamination of the base production wells was found during either round of sampling, if pumping patterns in the area change and natural flow patterns are partially re-established, the entire base well field could be down gradient from Site 1. If water from Site 1 did reach the base well field, contamination could move freely between aquifers, up and down the gravel pack of the production wells.

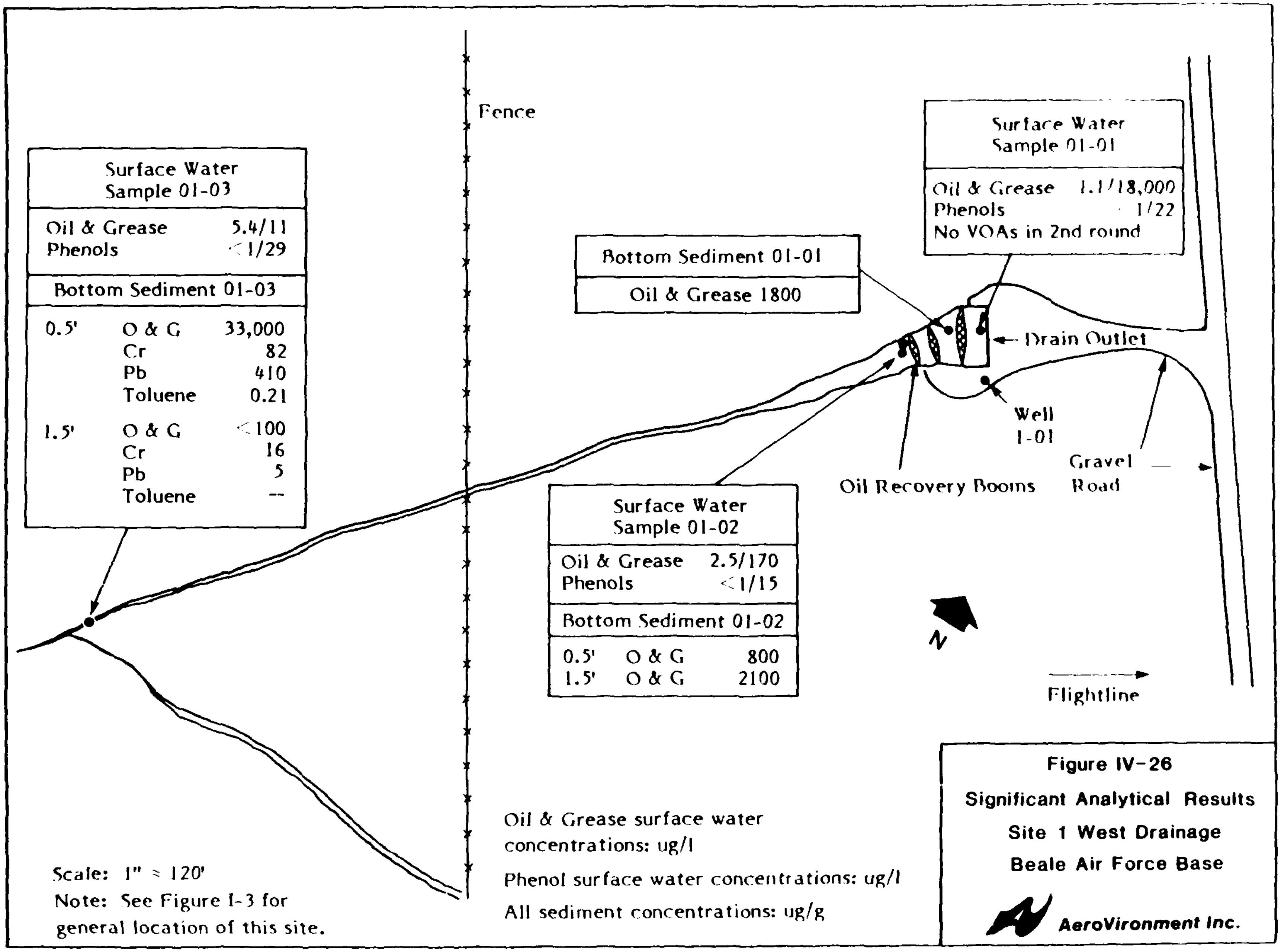
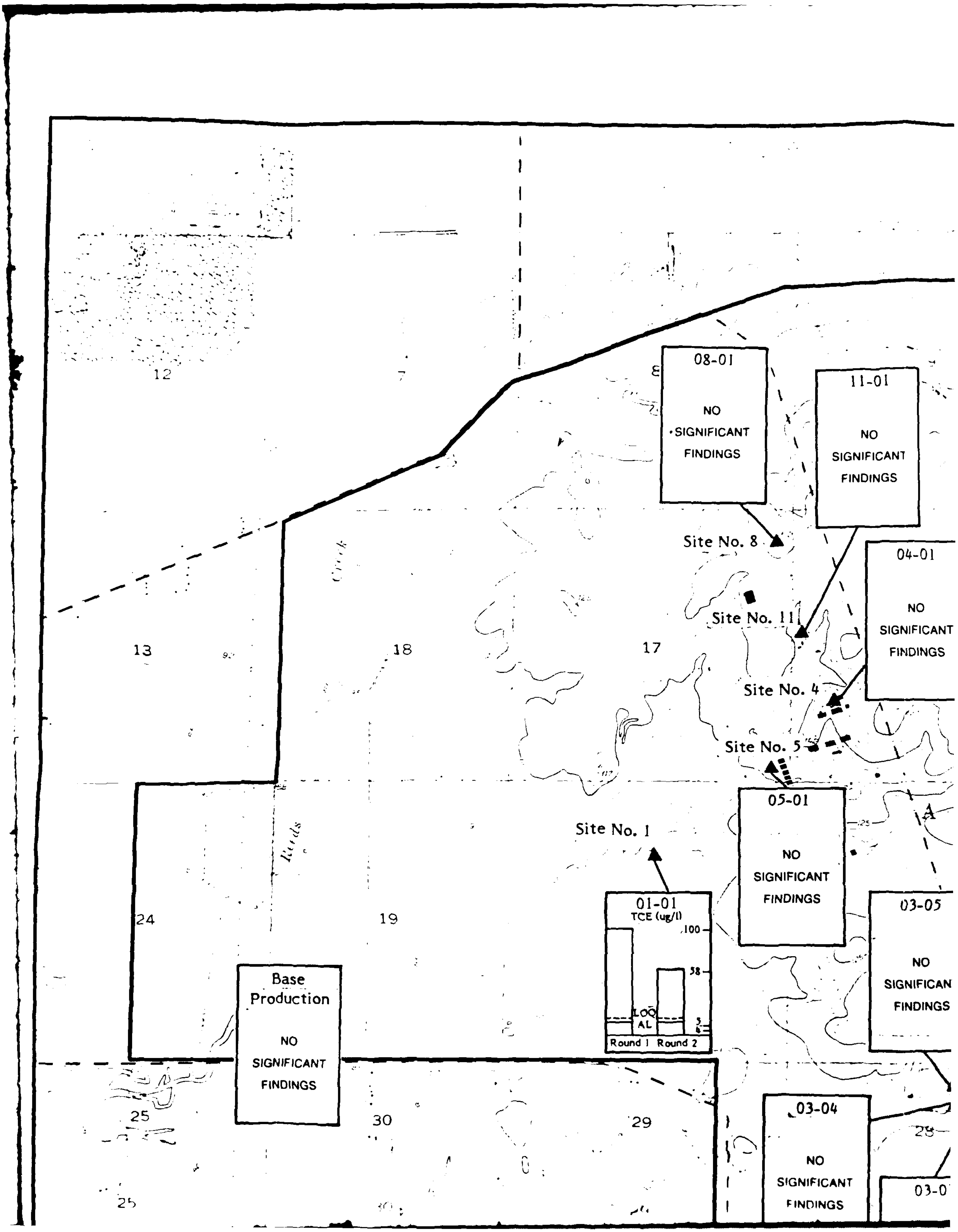
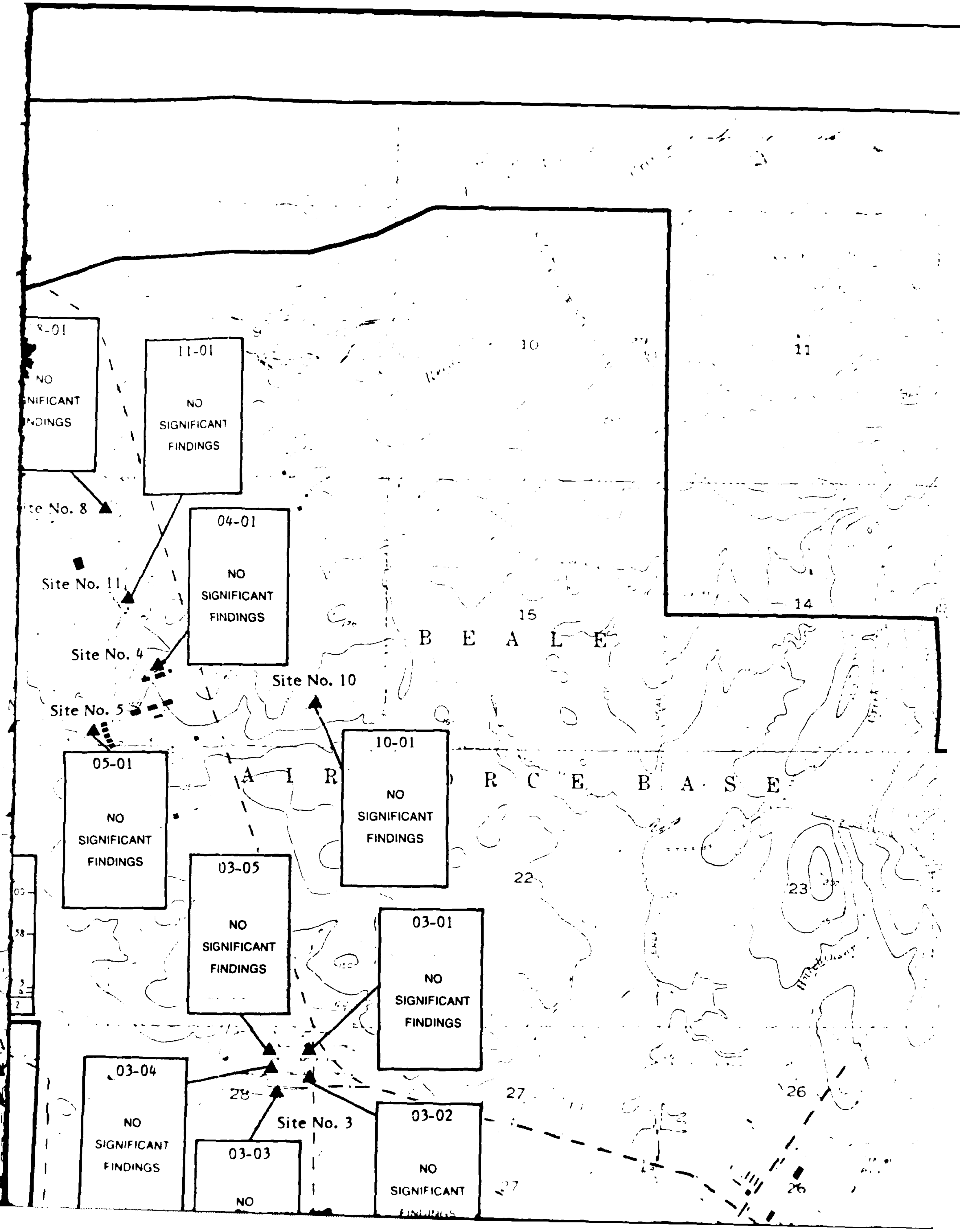
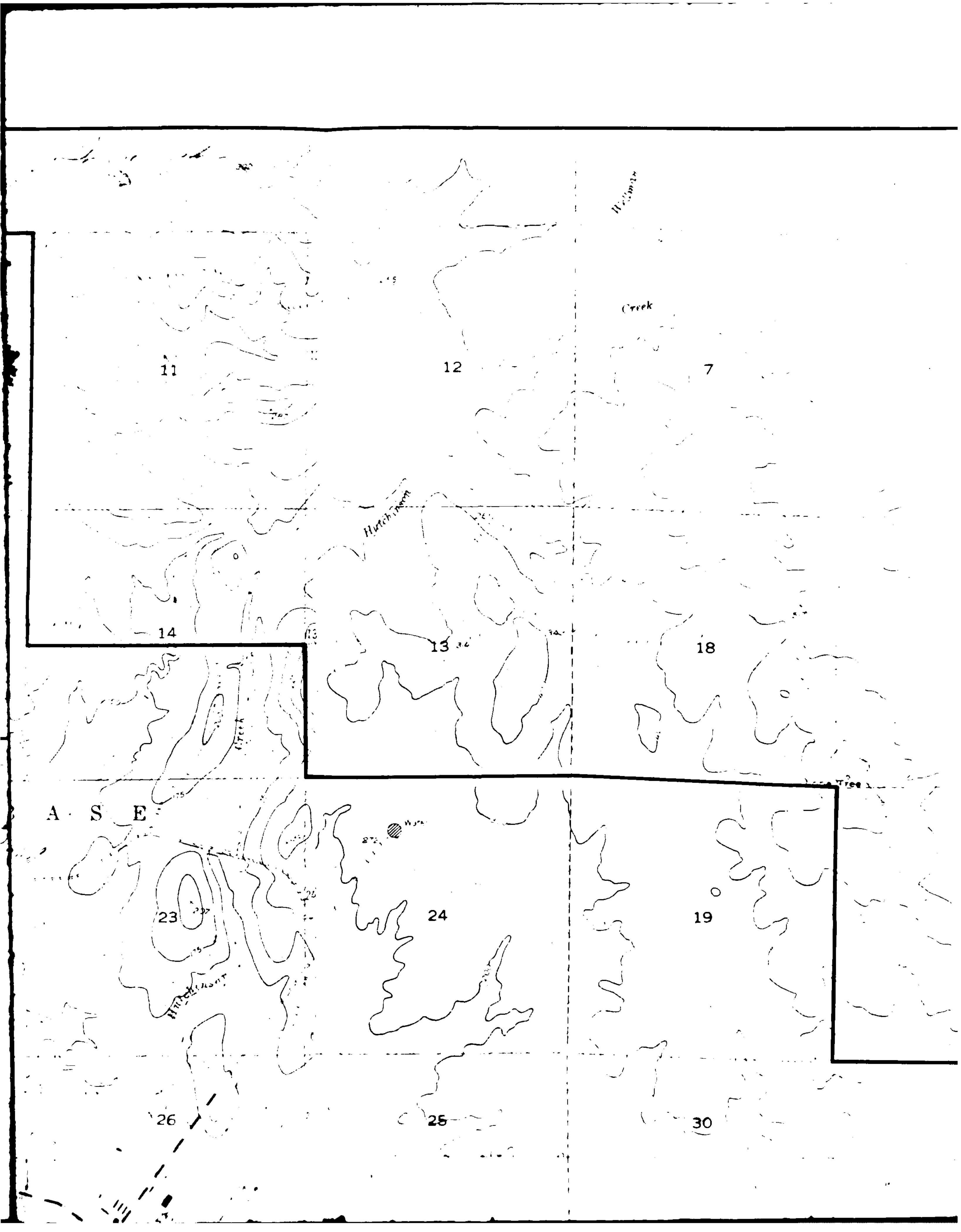


Figure IV-26
Significant Analytical Results
Site 1 West Drainage
Beale Air Force Base

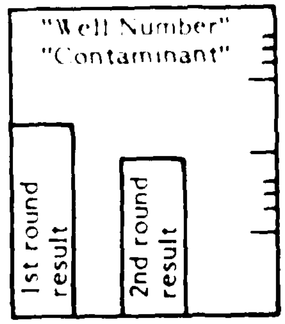

08-01
NO
SIGNIFICANT
FINDINGS
11-01
NO
SIGNIFICANT
FINDINGS
Site No. 8
04-01
NO
SIGNIFICANT
FINDINGS
Site No. 11
Site No. 4
Site No. 5
05-01
NO
SIGNIFICANT
FINDINGS
Site No. 1
01-01
TCE (ug/l)
100
58
LOQ
AL
Round 1
Round 2
03-05
NO
SIGNIFICANT
FINDINGS
Base
Production
NO
SIGNIFICANT
FINDINGS
03-04
NO
SIGNIFICANT
FINDINGS
12
7
13
18
17
24
19
25
30
29
28



11-01
NO SIGNIFICANT FINDINGS
04-01
NO SIGNIFICANT FINDINGS
Site No. 11
Site No. 4
Site No. 5
Site No. 10
05-01
NO SIGNIFICANT FINDINGS
10-01
NO SIGNIFICANT FINDINGS
03-05
NO SIGNIFICANT FINDINGS
03-01
NO SIGNIFICANT FINDINGS
03-04
NO SIGNIFICANT FINDINGS
03-03
NO
Site No. 3
03-02
NO SIGNIFICANT
BEALE
AIR FORCE BASE
10
11
14
15
22
23
26
27
28



Creek
11
12
7
Hutchinson
14
13
18
Creek
A S E
24
23
19
Hutchinson
26
25
30



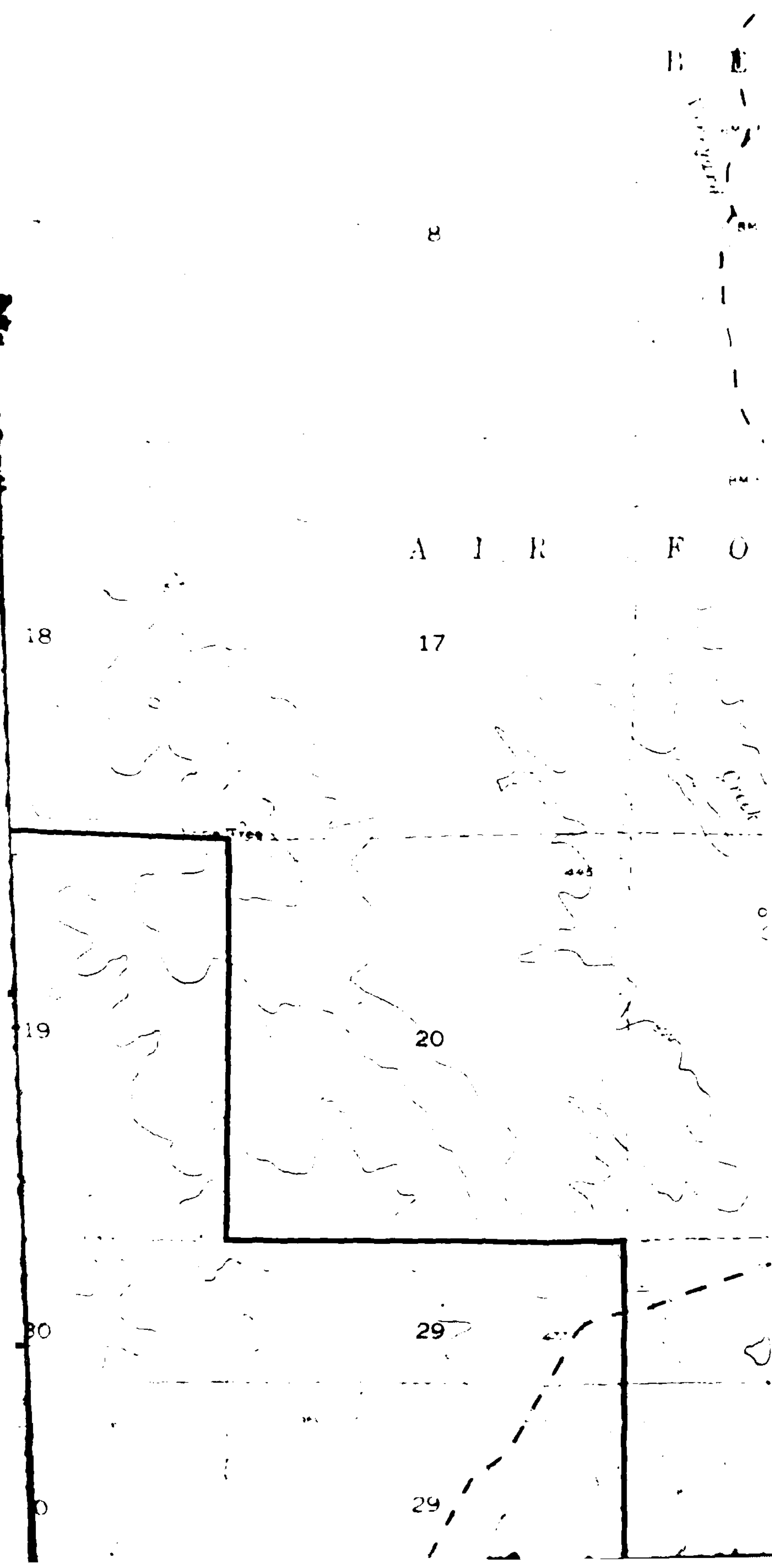
Concentration, in ug/l, logarithmic scale as shown

The following are also shown, where appropriate:

AL = DOHS Action Level

LOQ = Level of quantification (5 X detection limit).

PDWS = Primary drinking water standard



Note:

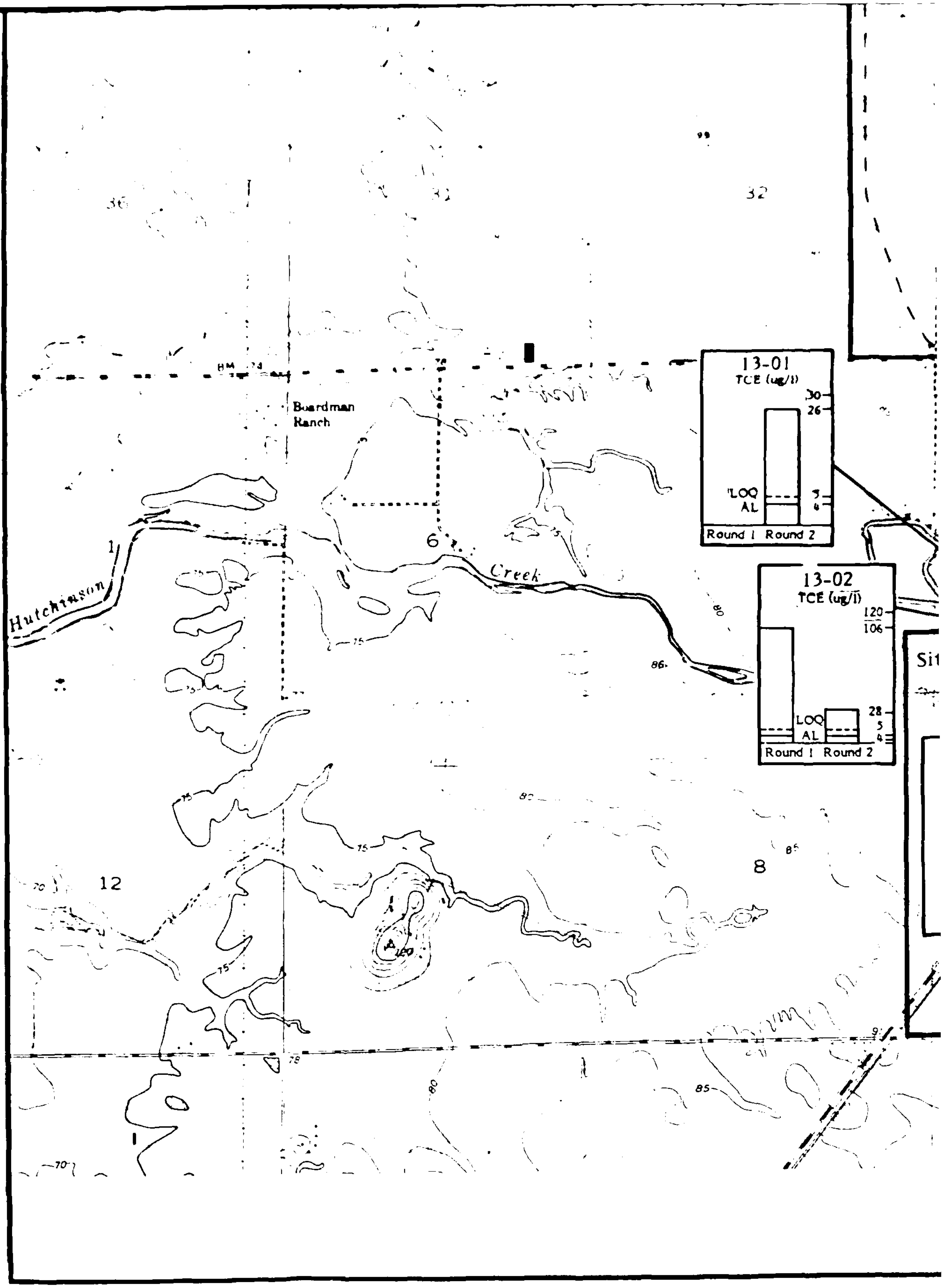
The terminology of "No Significant Findings" is used on wells which have not shown levels of contaminants above the criteria levels presented in the text of the report. In general, these criteria are:

- Concentration greater than the method LOQ
- Reproducability between rounds
- Concentrations above action levels (either DOHS or federal)

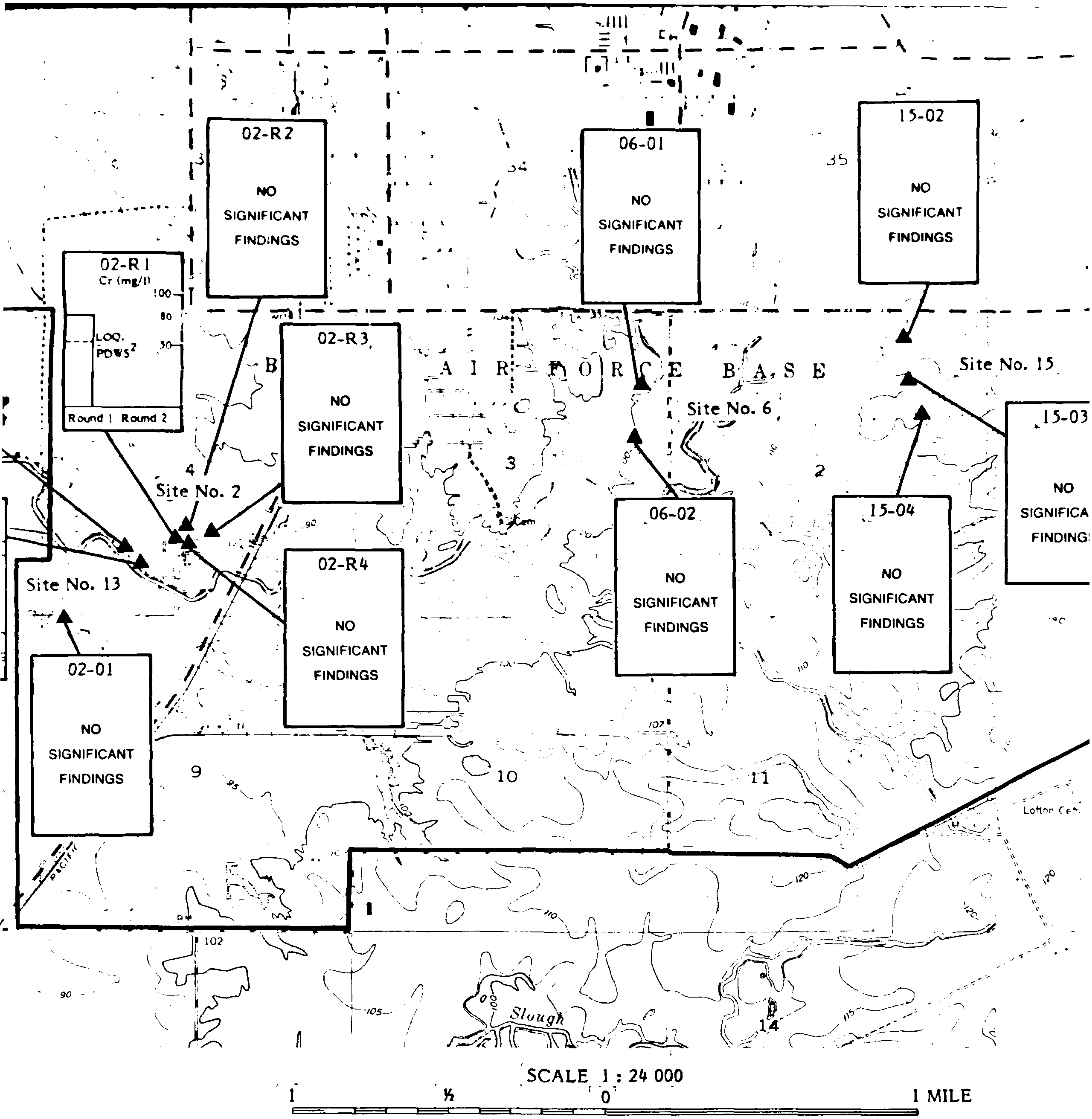
Footnotes:

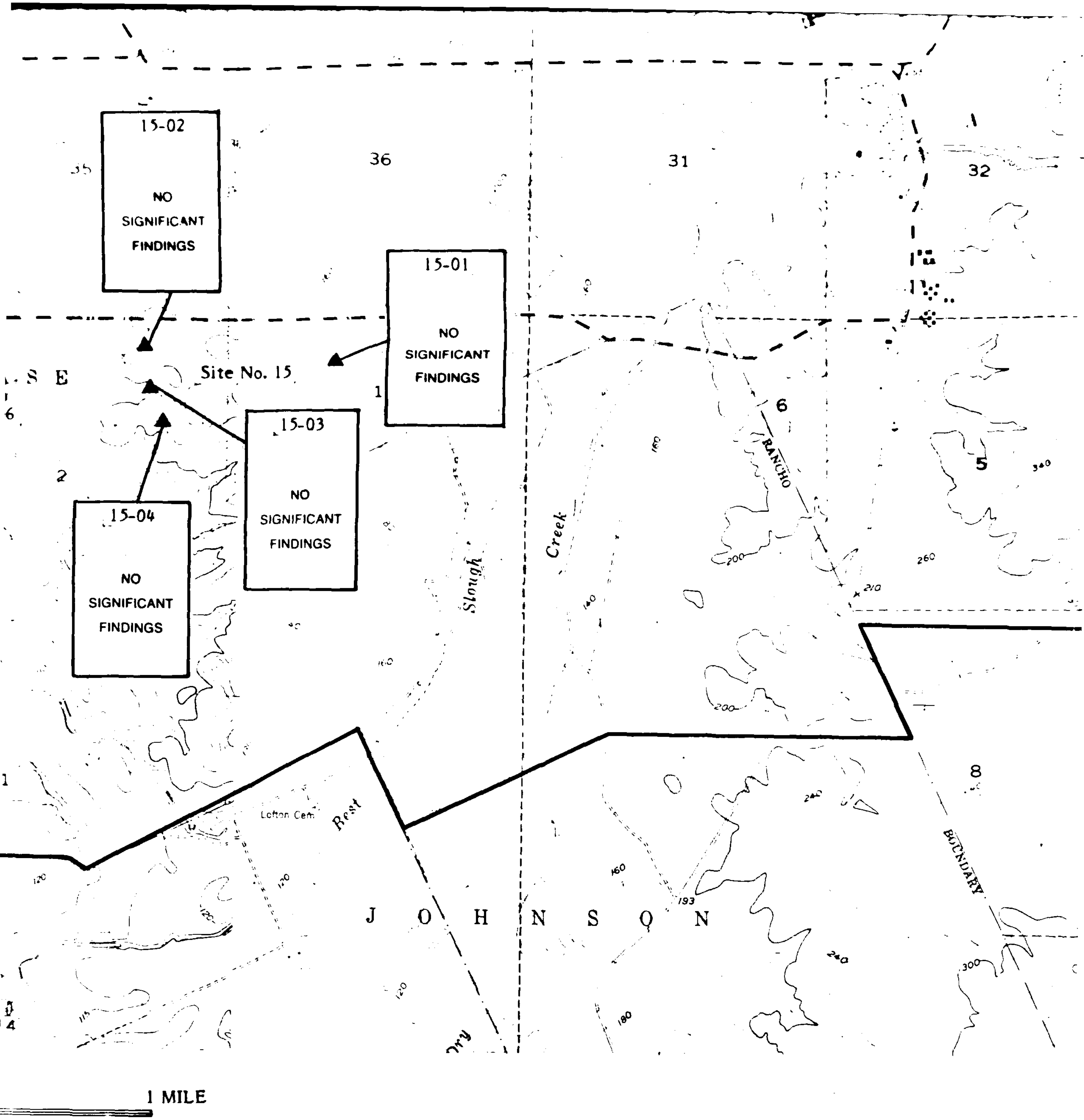
1. Only concentrations which exceed both the DOHS action level and the level of quantification (5 X detection limit) are shown.

2. Chromium does not have a DOHS action level, the primary drinking water standard is shown.



36
31
32
BM
Boardman
Ranch
6
Hutchinson
Creek
12
8
75
80
85
86
70
120
13-01
TCE (ug/l)
30
26
LOQ
AL
5
4
Round 1 Round 2
13-02
TCE (ug/l)
120
106
28
LOQ
AL
5
4
Round 1 Round 2


02-R2
NO SIGNIFICANT FINDINGS
06-01
NO SIGNIFICANT FINDINGS
15-02
NO SIGNIFICANT FINDINGS
02-R1
Cr (mg/l)
100
80
50
LOQ.
PDWS2
Round 1
Round 2
02-R3
NO SIGNIFICANT FINDINGS
B
AIR FORCE BASE
Site No. 15
Site No. 6
15-03
NO SIGNIFICA
FINDING
Site No. 2
06-02
NO SIGNIFICANT FINDINGS
15-04
NO SIGNIFICANT FINDINGS
Site No. 13
02-R4
NO SIGNIFICANT FINDINGS
02-01
NO SIGNIFICANT FINDINGS
Cem
Lofton Cem
Slough
35
34
3
4
2
9
10
11
14
102
120
110
105
90
SCALE 1 : 24 000
1
½
0
1 MILE


15-02
NO SIGNIFICANT FINDINGS
15-01
NO SIGNIFICANT FINDINGS
15-03
NO SIGNIFICANT FINDINGS
15-04
NO SIGNIFICANT FINDINGS
Site No. 15
36
31
32
6
5
8
2
1
Slough
Creek
RANCHO
BOUNDARY
Lofton Cem
Rest
J O H N S O N
200
210
260
240
300
193
160
180
140
120
1 MILE

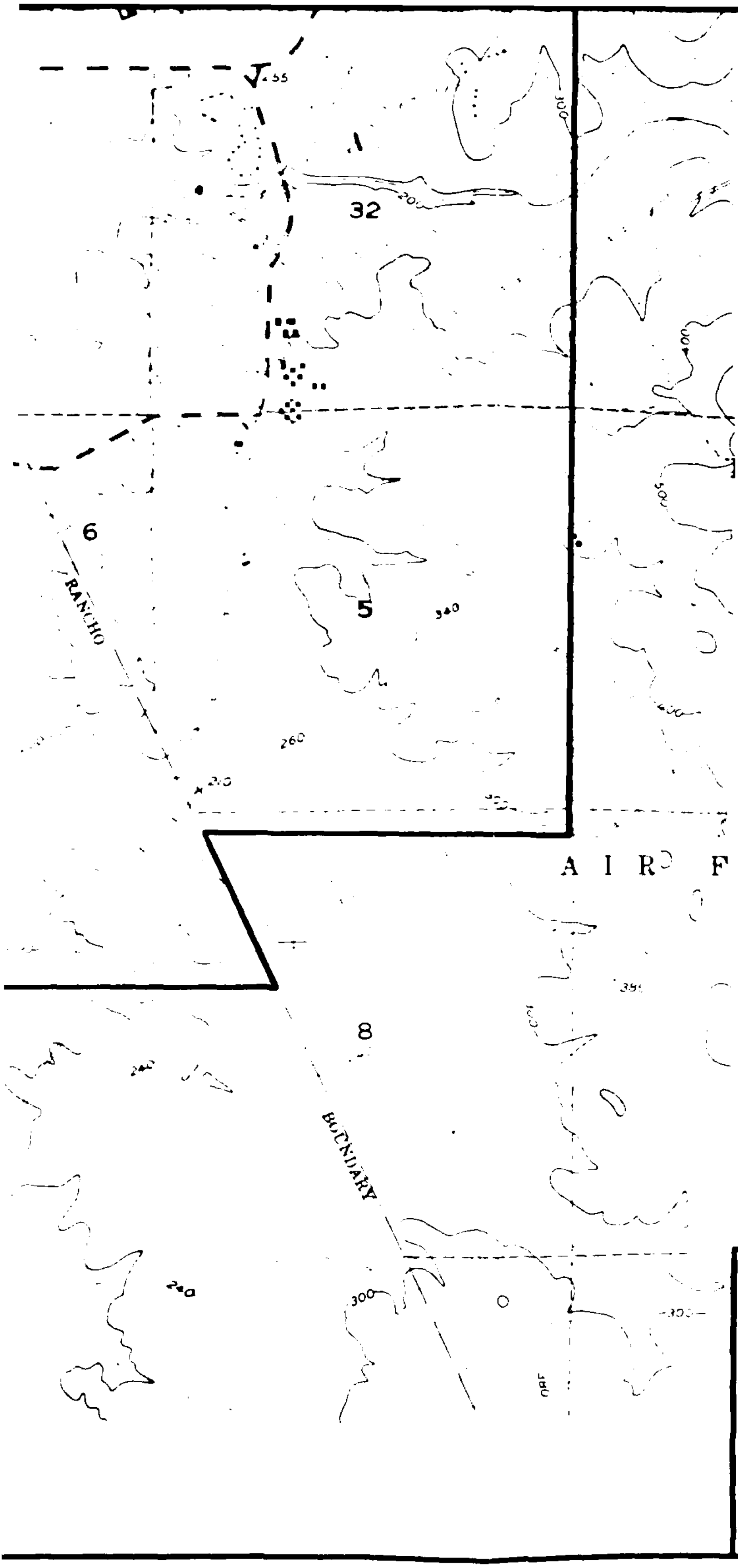


Figure IV-27

Groundwater Sampling Results[1]

Beale Air Force Base

AeroVironment Inc.

Site 2 [illegible] Well No. 2 Photo Wastewater Treatment Plant

Soil samples were collected from four borings near the Injection Well System and one groundwater monitoring well was installed. In addition, the four wells previously installed around the Photo Waste Water Treatment Plant were sampled during this program.

The soil borings were placed in locations where surface spillage was thought to have occurred near two of the wellheads and at the end of the pipeline. It had been reported that wellhead filters were cleaned or changed periodically and that the plant effluent spilled onto the ground either during the changing process or during backflushing. This procedure has not been used since 1984. The pipeline is periodically flushed by uncapping the end of the pipeline and allowing effluent to flow out of the pipe. None of the soil borings showed any evidence of contamination of the upper 12 feet of soil. The 16.5-foot sample from Boring 4 was found to contain 30 µg/g of pentachlorophenol (PCP), which exceed the TTLC 17 µg/g. Unfortunately, no other samples from that depth were analyzed. Whether additional contaminants exist in the deeper soils is unknown. PCP is relatively mobile in soil. Use of it as a corrosion inhibitor in the effluent has been reported. It is possible that the PCP has moved vertically through the soil. Additional sampling at lower levels would provide further definition of possible contamination.

Water samples collected from the well located within five feet of Boring 4 showed no significant concentrations of contaminants; however phenol was measured at 2 µg/l in the first round. Additional work will be necessary to evaluate the possibility of deeper soil contamination near the wellheads and to

...te the information on pentachlorophenol and phenol in soil, groundwater ... process effluent.

Water samples were collected from the four previously ... Radian wells. Analytical results from the first round showed 5 µg/l of total ... but no other repeatable, significant results were identified. Radian Well No. ... not sampled in the first round because of an obstruction in the well. ... obstruction was removed before the second round and a sample was taken. The ... of the well was about 12.0. The sample from Radian Well No. 1 contained ... at a concentration of 5 µg/l, and chromium at 80 µg/l. The primary drinking ... standard for chromium is 50 ug/l, as is the LOQ. The chromium presence ... is considered significant, although the repeatability cannot be verified ... Figure IV-27). The chromium level very closely matches previous results ... well (Radian, 1985), but the phenol concentration is much lower than ... result (5 ug/l vs. 21 ug/l).

The fact that phenol and total phenolics were ... wells is not surprising. These compounds have been found at ... previous samplings and are constituents in the wastewater ... the drying beds (Radian, 1985). The concentrations of ... but are not extremely high.

o Site 3 -- Fire Protection Training Area ...

Contamination is usually found at ... reason this site was investigated very thoroughly. FPTA ... fire pits in which waste oil, fuel and solvents are ... practice controlling and extinguishing the fire. ... the pit to evaporate or percolate. FPTA No. ...

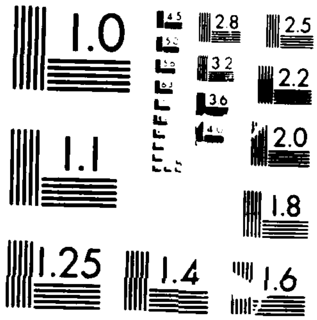
Five groundwater monitoring ... effects of the FPTA on the water table aquifer ... fine-grained material and recharge ...

AD-A183 968 INSTALLATION RESTORATION PROGRAM PHASE 2 CONFIRMATION/QUANIFICATION STAGE..(U) AEROVIRONMENT INC MONROVIA CA R BAUER 29 MAY 87 AV-FR-86/517R2-VOL-1

4/4

UNCLASSIFIED F33615-83-D-4000 F/G 24/4 NL

END
DATE
FILMED
10 87



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

produce fast enough to be useful for domestic or agricultural supply. The water table is very steep in this area. The first confined aquifer, located below the water table aquifer, is separated from the water table by 40 feet of clay. The head on the confined aquifer in this area is such that any leakage between it and the water table would be upward, which would serve to protect the usable ground water supplies.

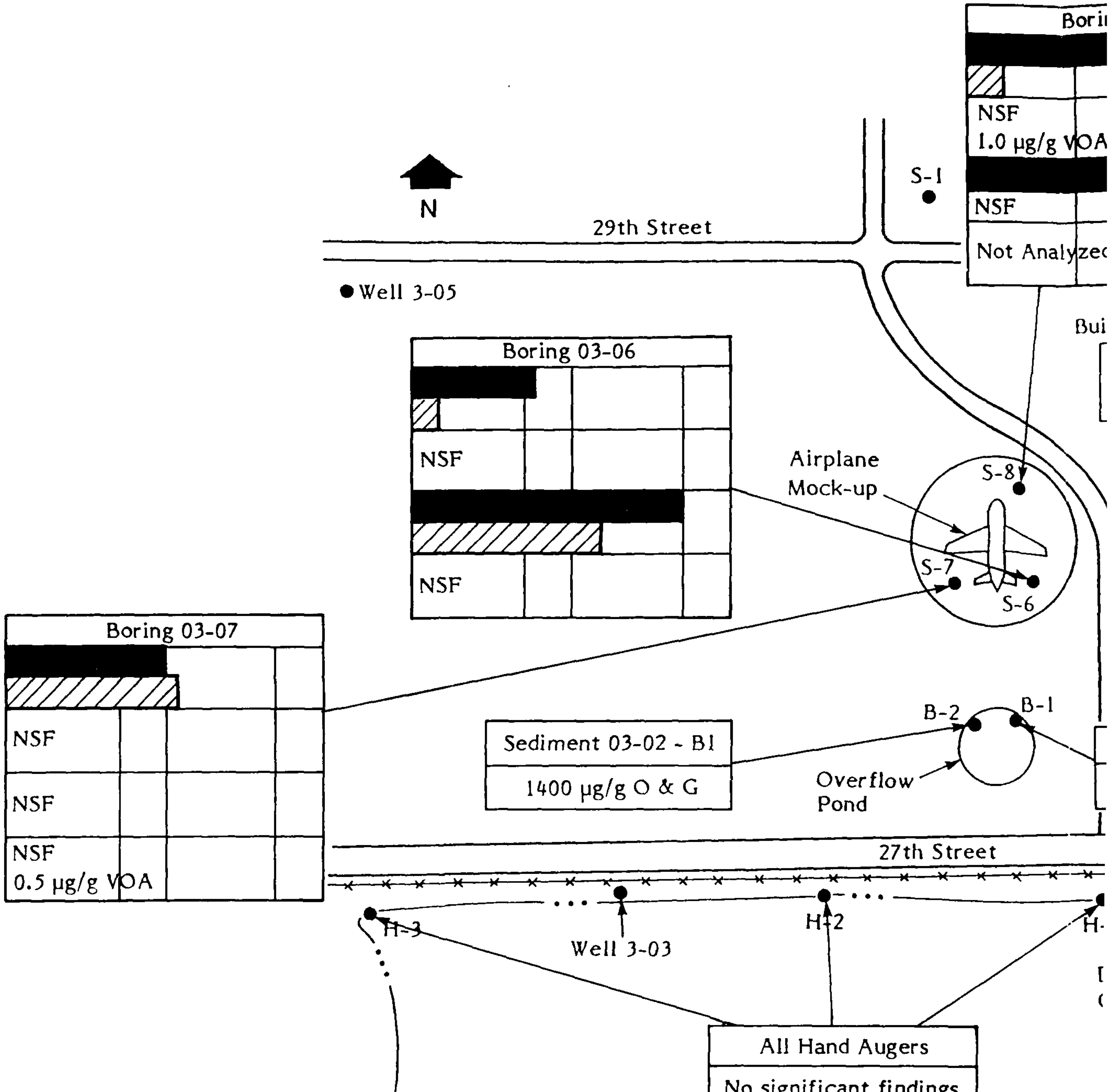
The analytical results from the five groundwater monitoring wells indicate that no degradation of the water table has occurred. This is somewhat surprising, given the history of problems at most FPTAs at bases around the country; however, the presence of hard soils under the site and the limited use of the training area have apparently helped minimize the impact to groundwater.

Eight deep soil borings (16.5 feet), three shallow hand-auger samples (2 feet), and two surface sediment samples were collected to characterize the shallow soils in the area. The only contamination identified at the site are inside the berm of FPTA No. 2 and near the underground tanks used to store solvents and POL waste prior to burning at the FPTA. Soil samples collected in these areas show O&G (800 µg/g) and volatile/purgable organics (1 µg/g) in soils between the surface and 16 feet (see Figure IV-28). The lower extent of contamination has not been determined, since one hole showed elevated O&G concentrations in the bottom sample. Additional sampling around the underground tanks and the bermed FPTA No. 2 will be required to determine the vertical extent of contamination. Groundwater has not been affected by the activities of the FPTA.

- <u>Site 4</u> -- Battery Shop Dry Well

One groundwater monitoring well was installed near the Battery Shop Dry Well to evaluate possible contamination from this site. AV located the monitoring well about 25 feet from the Dry Well, which is approximately 20 feet deep. During well installation, AV encountered an area of discolored fine sands at 45 to 50 feet, which may have been caused by the neutralized acid which migrated downward 25 to 30 feet from the point of introduction into the soil. However, the

THIS PAGE LEFT BLANK INTENTIONALLY



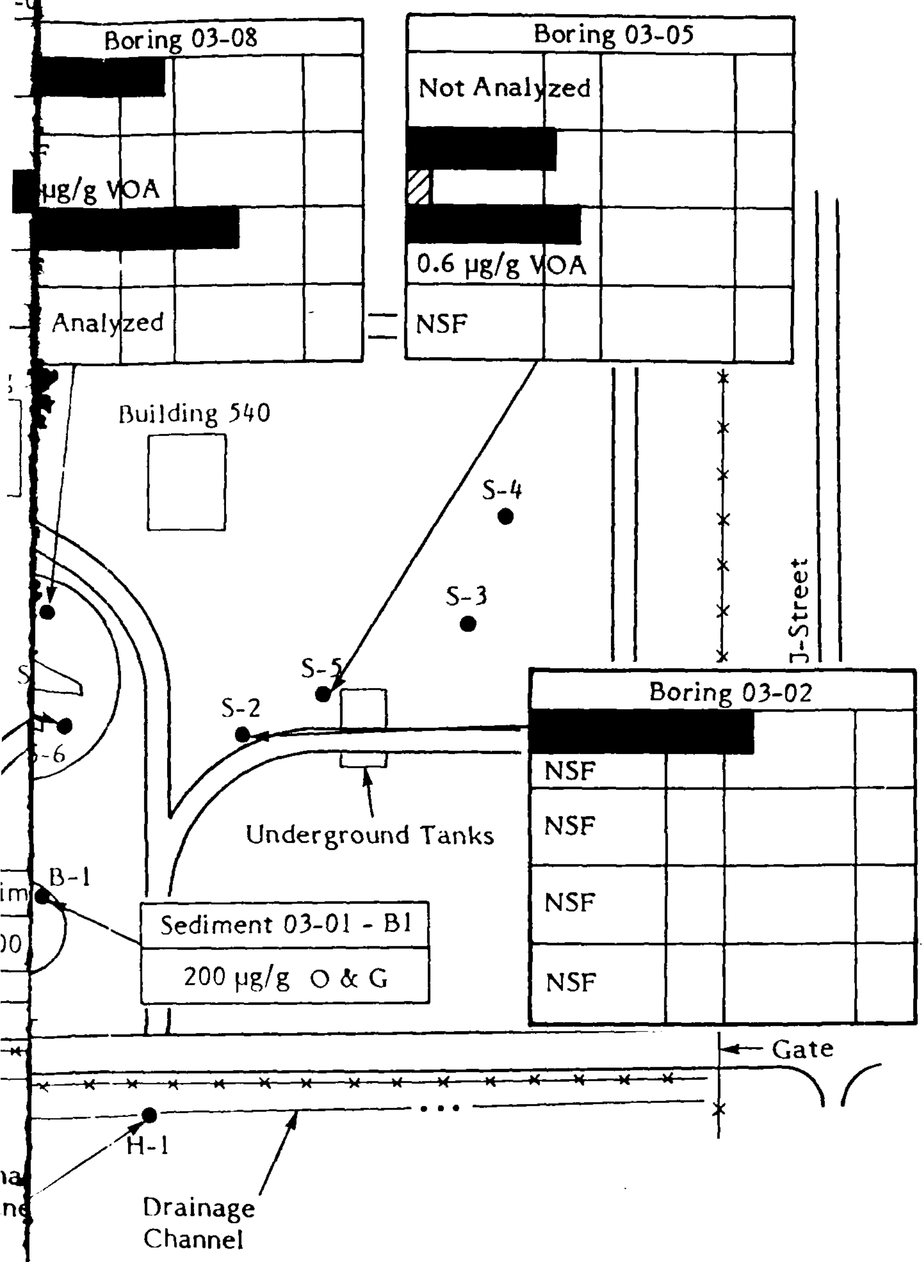
See Table IV-5 for specific results.

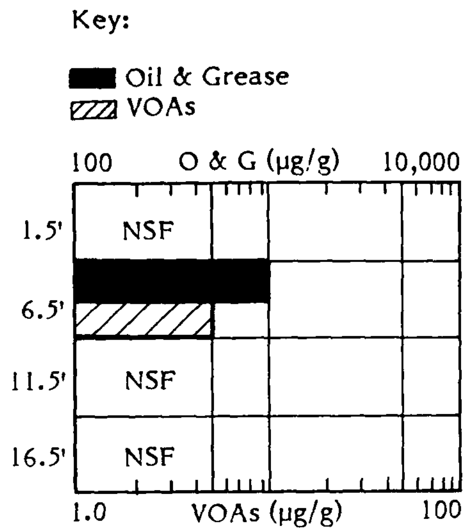
Petroleum hydrocarbon concentrations are roughly equal to the O & G concentrations

NSF = No significant findings

Results which are not plotted were found to be at or below background concentrations including all samples from Borings 03-01, 03 or 04.

Scale 1" ≈ 120'





The results of the Oil and Grease and VOA testing are plotted as bar graphs. These plots are intended to show approximate concentrations.

In the above example, there are no significant findings for either VOAs or Oil and Grease at sampling depths of 1.5, 11.5 and 16.5'. However, the VOA concentration was about 5 μg/g (use lower scale) and the Oil and Grease concentration was 1000 μg/g (upper scale).

Figure IV-28

Significant Analytical Results

Site 3, FPTA #1 and #2

Beale Air Force Base

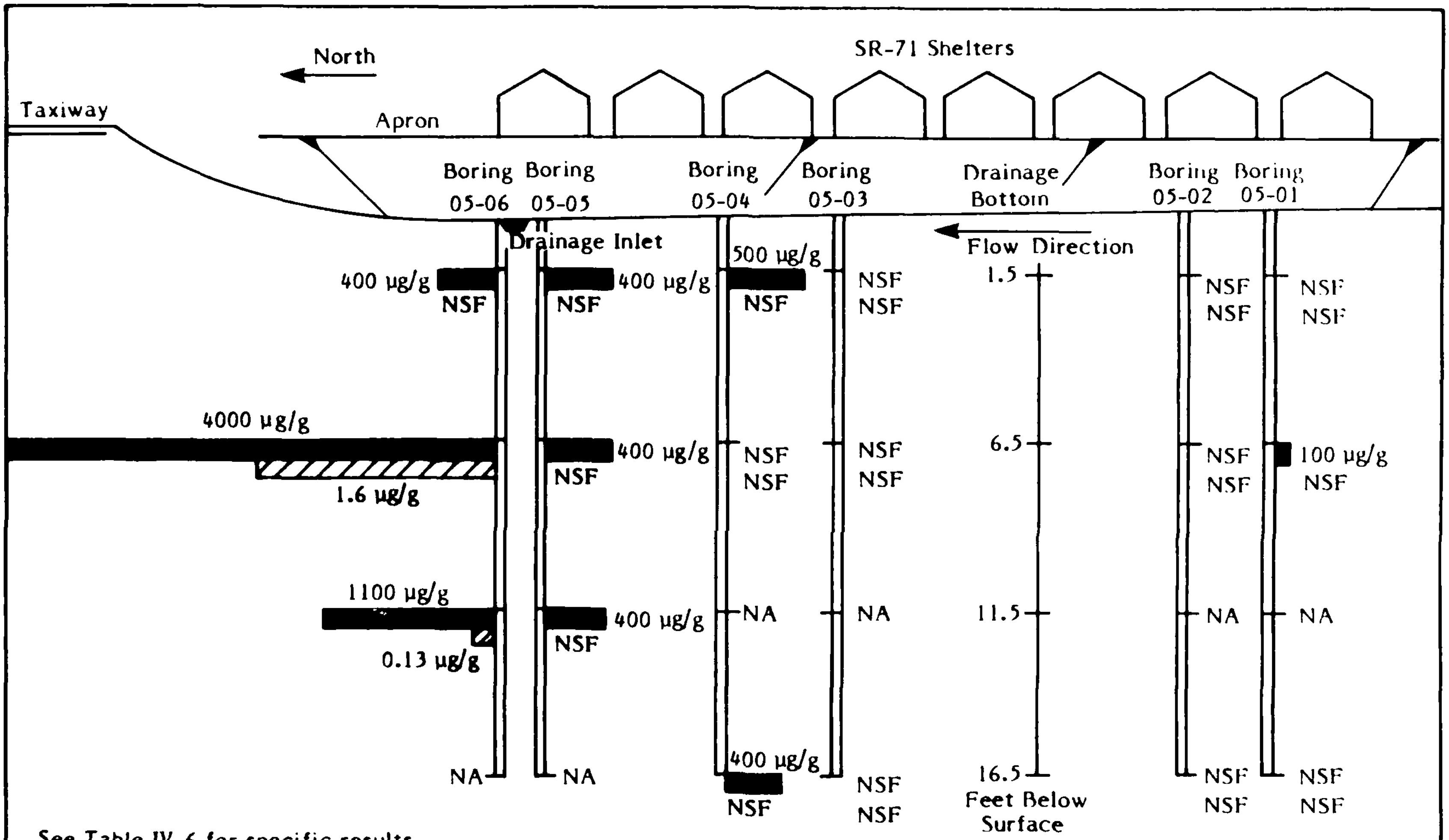
AeroVironment Inc.

staining did not appear to be a layer of deposited metal. No visual indication of dry well impacts was found below 50 feet and the groundwater beneath the site was not contaminated. Any contamination resulting from past waste disposal practices at the site appears to have been quickly immobilized in the soil. The practice of dumping neutralized battery acid into the well was discontinued in 1983 and most of the area is surrounded with asphalt, which would eliminate the driving force to move potential contaminants closer to the water table. Evidence indicates that Site 4 is not a threat to the environment.

- Site 5 -- SR-71 Shelter

One groundwater monitoring well was installed and six soil borings were drilled to investigate for possible soil contamination at Site 5, the SR-71 Shelter. Aviation gasoline and other hydrocarbons spilled on either the taxiway or the SR-71 shelter apron drain into the gravel area between the two. Surface runoff is generally into the drainage swale and then along the swale to the storm sewer inlet. The storm sewer empties at Site No. 1, the West Drainage. All of the sampling locations were placed along the bottom of the drainage swale, with the well near the sewer inlet. No evidence of groundwater contamination was found at this site, but three of the soil borings showed hydrocarbon levels between 400 and 4000 µg/g (see Figure IV-29). The highest concentrations of contamination were found in the northern borings, nearest to the inlet. This area also has the greatest visual evidence of spillage. The soil contamination is probably limited to a narrow strip of soil near the drain, but no sampling was done away from the swale centerline. The depth of contamination at this location is unknown, since all three northern borings showed significant O&G contamination in the deepest sample (16.5 feet). However, the hardpan soil and clay encountered during the drilling of the monitoring well could protect groundwater.

Although groundwater in this area is 116 feet below the ground surface and has not been degraded to this time, if present practices continue, it may eventually become degraded beneath this site. The continued application of fuel to the soil would serve as a driving mechanism to accomplish this. More



See Table IV-6 for specific results.

Horizontal Scale

1" = 1000 μg/g
(for oil and grease)

1" = 1 μg/g
(for total 8020 hydrocarbons (BTX))

Key

Oil and Grease
Total 8020 Hydrocarbons (BTX)
NSF No Significant Finding
NA Not Analyzed

Figure IV-29
Significant Analytical Results
Site 5, SR-71 Shelter
Beale Air Force Base

AeroVironment Inc.

sampling of the soil at this site will be required to determine the magnitude of the problem. At this time there is some threat to groundwater, and the serious problem is the contribution to surface runoff problems at Site No. 1.

o Site 6 -- Landfill No. 2

Two wells were installed down gradient from Landfill 2. Four additional wells were installed up gradient of Landfill 2 as part of the investigation of Landfill 3. Laboratory results showed no contamination in either of the two wells. The landfill operated from 1950 to 1980 and received some Photo Wastewater Treatment Plant sludge but no other significant quantities of hazardous waste have been reported to be buried at this site. The soil's hardpan layers and the silty Laguna Formation, which underlies the site, would help to inhibit movement of any contamination from the surface. Landfill 2 does not appear to threaten the environment.

o Site 7 -- Biological Production

The samples were collected from the top six inches of soil at sixteen locations around an old biological production site and composited. The analysis of the four composite samples showed no organic concentrations and only sightly elevated silver concentrations (2.5-12 μg/g). The silver concentrations are not considered to be significant in terms of environmental contamination. This lack of serious problems was expected, since Army documents reviewed during the Phase I record search reported that all chemicals used at the biological production facility had been incinerated and that no contamination existed at the site. Results of this sampling program support those documents. No environmental contamination appears to exist in either soils or groundwater at this site.

o Site 8 -- J-57 Test Cell

One well was installed to monitor groundwater at the site of the J-57 Test Cell, and six shallow hand-auger samples were collected in the drainage ditch around the site to determine whether the soil had been polluted by surface

unoff. Spills from the engine tests are washed off the pavement and into the unlined drainage channel. Nothing significant was found in the groundwater. The hand-auger sample at the upgradient location contained 700 µg/g oil and grease and 1400 µg/g petroleum hydrocarbon at the 1.5-foot level. This corroborates visual observations of oil stains at that location. The test cell fuel storage tank is above ground in a bermed area. Chances of a spill that would cause widespread contamination is low. This site has no evidence of groundwater contamination or of widespread soil contamination.

- <u>Site 9</u> -- Entomology Building 2560

Soil samples collected at Entomology Building 2560 showed localized contamination. This building is currently used for storage, mixing and cleanup (container rinsing) of pesticides and herbicides used for weed and rodent control at Beale AFB. Part of the mixing and cleanup operation is conducted in a small 6-foot by 6-foot gravel-mixing basin on the south side of the building. Rinsate or spillage is discharged onto the ground. Soil immediately down slope from the gravel basin has no vegetation. This appears to be the result of contaminated surface runoff from the mixing operations.

The soil sample collected from the 1.5 feet below the gravel basin contained 0.9 µg/g of the insecticide chlordane. Chlordane was also found in the 6.5-foot sample, but at only 0.1 µg/g. Chlordane concentrations found in both samples are well below the state Total Threshold Limit Concentration (TTLC) value of 2.5 µg/g. No other contaminants were found in the mixing basin. A boring was drilled in the bare soil down slope from the basin, but no contamination was found in samples from that location.

The presence of chlordane in the shallow soils indicates that localized contamination is occurring as a result of Entomology Shop operations. Management of the mixing and/or rinsing operations should be modified to eliminate further release of pesticides and herbicides into the unlined basin (or overflow outside the basin). However, the fact that chlordane was found at a very low level (barely above detection limit) in the 6.5-foot sample and not at all in the

down-slope sample indicates that the potential for broader contamination from this site is low. The health risk is also considered to be low.

- Site 10 -- J-58 Test Cell

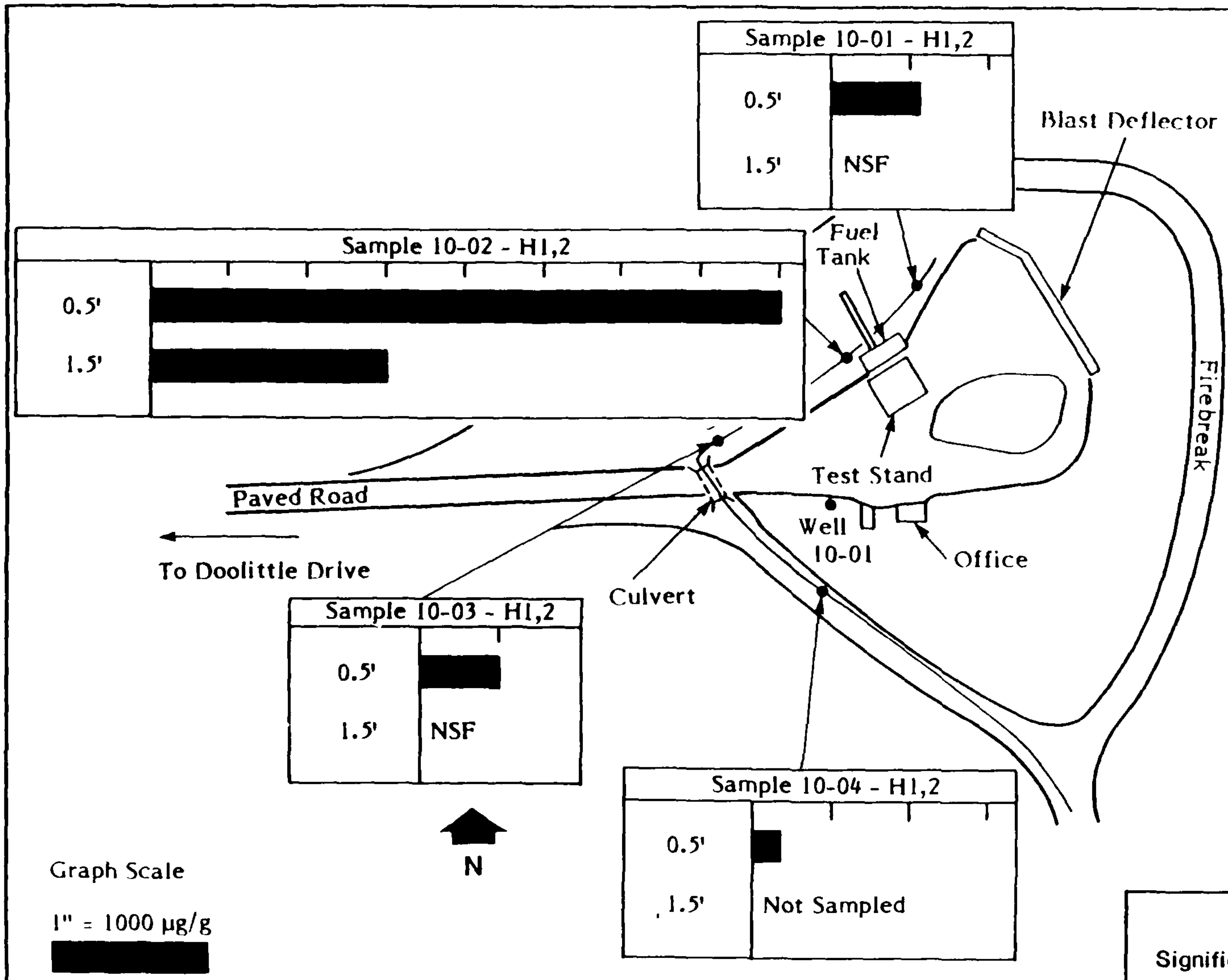
One groundwater monitoring well was installed at the site of the J-58 Test Cell to monitor groundwater quality, and hand-auger samples were taken at four locations in the drainage ditch surrounding the test cell. Fuel and oil spills that occur during testing of SR-71 engines are washed from the test stand and flow into the drainage channel on the north side of the stand.

O&G and petroleum hydrocarbon contamination was found in the surface samples from all the hand borings (see Figure IV-30). However, at the 1.5-foot depth only one boring still showed elevated oil and grease concentrations (1600 µg/g). The sample (10-02-H2) that had deeper contamination also had the highest concentrations in the surface sample. It is located near a small undiked, above-ground fuel tank located between the test stand and the channel. Also, most washdown from the test stand probably enters the channel near Hand Auger Location 10-02, judging by soil staining at the site. The main fuel tanks for the J-58 Test Cell have double containment to eliminate any leakage.

The J-58 test cell shows evidence of some environmental degradation resulting from fuel spilling and equipment washdown. Soil contamination is localized and probably shallow, as would be expected from an operation such as this. There is no evidence of groundwater contamination. The risk from this site is considered minimal.

- Site 11 -- AGE Maintenance Shop

The main source of contamination at Site 11 is runoff of fuel, lubricants and engine oil onto the soils bordering the back parking area at the AGE Maintenance Shop. Contamination may also spread to the drainage ditch behind the building. Routine maintenance of aircraft ground equipment (AGE) is conducted in the back parking area and spills are usually washed off the pavement



-All results are oil & grease concentrations,
petroleum hydrocarbon concentrations are similar.
-No other significant results identified
-NSF = No significant findings
Map Scale 1" = 120'

See Table IV-10 for specific results.

Figure IV-30
Significant Analytical Results
Site 10 J-58 Test Cell
Beale Air Force Base

AeroVironment Inc.

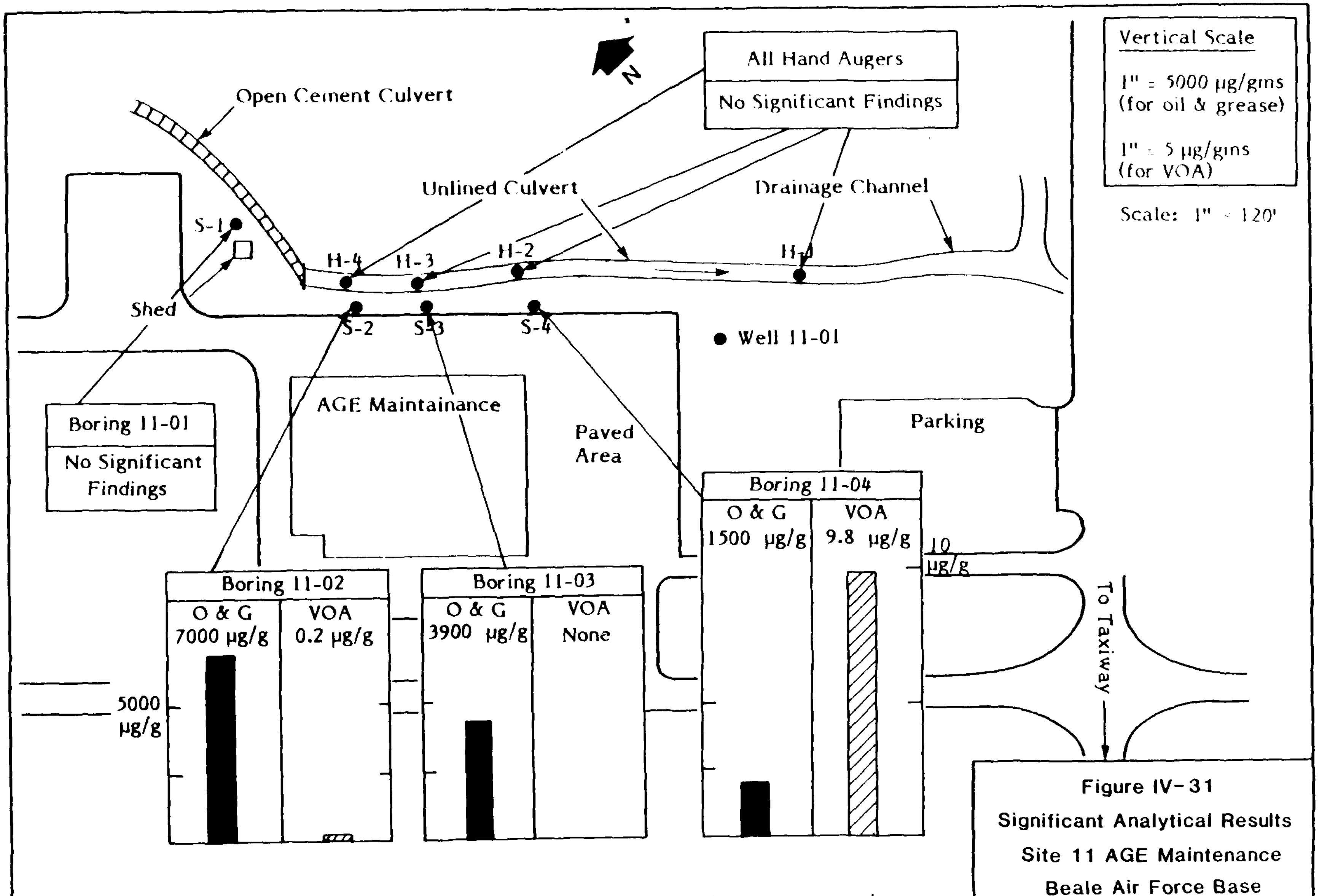
and allowed to evaporate or percolate into the ground. One groundwater monitoring well was drilled and sampled at this site. Four deep soil borings (16.5 feet) were drilled at the edge of the asphalt, where the runoff first makes contact with soil, and hand-auger samples (1.5 feet) were collected in the drainage ditch bottom.

All the soil borings near the edge of the pavement showed high levels of oil and grease, up to 7000 µg/g, in the 1.5-foot samples but were clean in 6.5-feet samples (see Figure IV-31). This is probably the result of very hard soil and relatively small quantities of material being discharged. No evidence of contaminants was found in the drainage ditch samples and the groundwater samples showed no indication of degradation. The highest concentrations of oil and grease contamination were found in Borings 11-02 and 11-03. The surface sample from Boring 11-04 also showed evidence of benzene, toluene and xylene, common constituents of the fuel used by AGE. The hydrocarbon concentrations at Borings 11-02, 11-03 and 11-04 correlate with the visual evidence of staining and the apparent flow patterns in the area.

Only localized surface hydrocarbon contamination was found at this site. The migration of contaminants, either laterally or vertically, is minimal. Due to the work practices at the maintenance shop, large-scale soil or water pollution is not expected; however, runoff of fuel and oil products will continue unless procedures change to preclude it. No groundwater contamination is evident. The environmental threat from this site is considered minimal.

- <u>Site 12</u> -- Entomology Building 440

Building 440 was used as the base entomology shop from 1965 to 1980. No records exist of specific activities at this building or of any particular mixing/rinsing basins similar to the one currently used at Building 2560. The building is now used by the base animal-control officer to house stray domestic animals.



-All results are for surface samples, no other significant concentrations encountered.
-See Table IV-11 for specific results.
-VOA is the total concentration of benzene, toluene and xylene compounds (BTX).

Figure IV-31
Significant Analytical Results
Site 11 AGE Maintenance
Beale Air Force Base

Two soil borings (plus a background boring) were drilled here to determine whether pesticide/herbicide contamination had resulted from past entomology shop practices. The two borings were located near a concrete pad southeast and down slope of the building that may have been used for mixing or loading chemicals. No significant contamination was found in any of the samples, nor is there visual evidence or odor around the site that would indicate contamination problems. No environmental threat from this site is anticipated.

o Site 13 -- Landfill No. 1

Landfill 1 occupies approximately four acres. It was used for disposal of base waste from the early 1940's to about 1950. Small quantities of household chemicals were probably included in the general refuse.

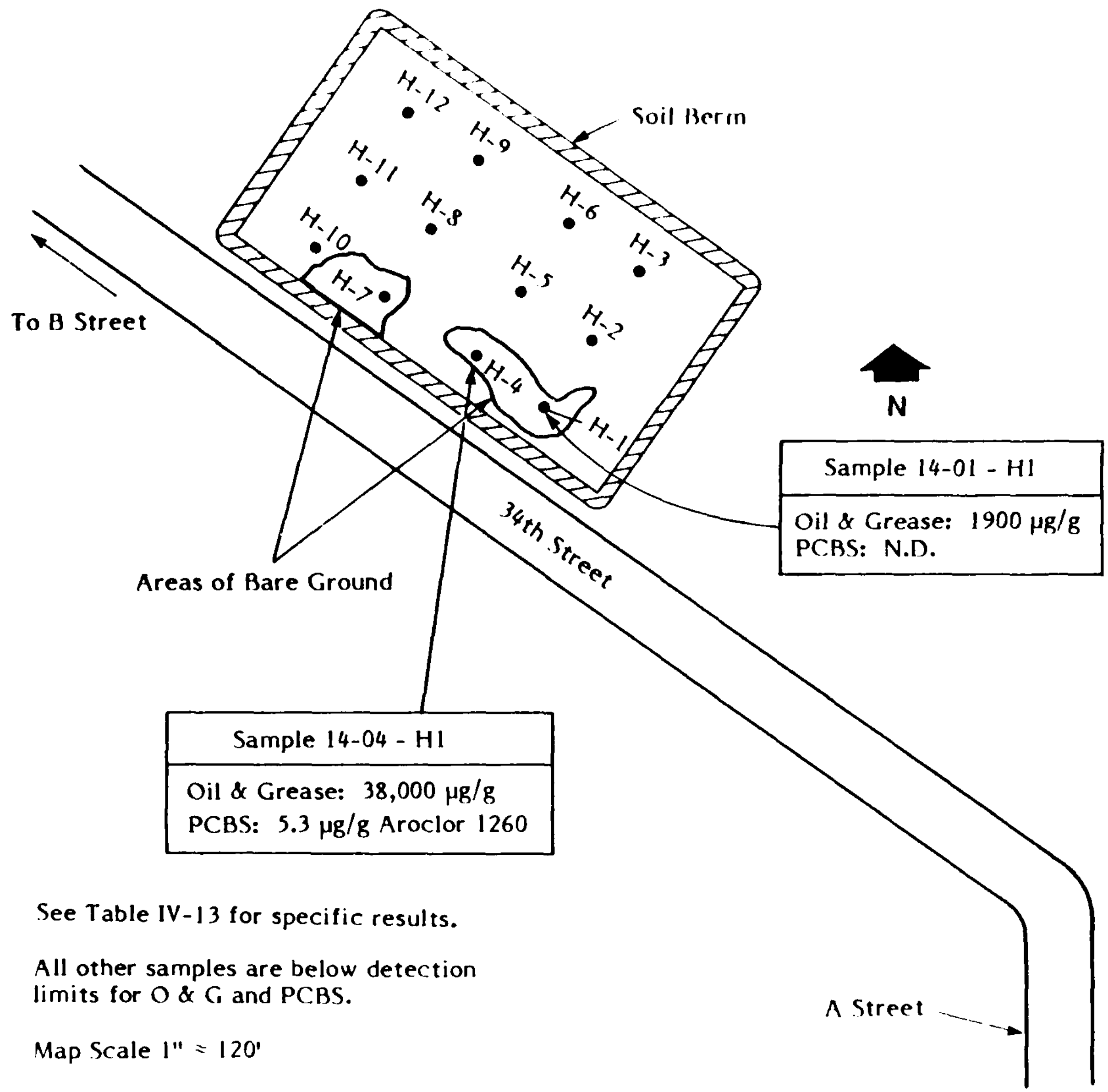
A geophysical survey using a magnetometer and ground-penetrating radar was conducted to locate any large magnetic anomalies and to define the site boundaries. Based on the results of the geophysical survey, two groundwater monitoring wells were drilled to monitor conditions beneath the landfill. High levels of TCE were found in both wells. Samples from the first sampling round showed 0.4 μg/l and 106 μg/l in Wells 13-01 and 13-02, respectively. The second round of tests showed 26 μg/l and 28 μg/l of TCE in the two wells, along with 3.7 μg/l of PCE in Well 13-02. The DOHS action level for TCE is 5 μg/l and 4 μg/l for PCE. Although the results are not precise, the fact that they were repeatable leads us to believe that TCE contamination does exist (see Figure IV-27). This finding is not easily explained. TCE contamination was unexpected in the groundwater at this site because of the age of the fill material and because TCE was not in general use by 1950 when the landfill was closed. Also, no other chemicals were found. While we are certain that TCE exists in the groundwater, the exact concentration and the source are unknown. Possible sources include the landfill, the Sewage Treatment Plant or the Photo Wastewater Treatment Plant; however, neither of the plants is considered a likely source, especially the Photo Wastewater Plant, because none of the wells there show TCE and TCE is not used in the process.

Surface water samples were taken at four locations along Hutchinson Creek where it comes near the southwest boundary of the landfill. Both sampling rounds were collected during low flow conditions, but the creek bed is deep and wide in this area so the water is almost stagnant. No contamination was identified during the first sample round, but low levels of the pesticides Lindane and Aldrin were detected during the second round. The Aldrin was detected in all four second round samples (including up gradient) at levels that ranged from 0.05 to 0.07 μg/l. This is considered significant since 0.05 μg/l is the California Department of Health Services' action level. Because Aldrin was found up gradient, the source of these pesticides is probably not from a point source, but rather runoff from various areas of the base or possibly from agricultural areas that surround the base. Additional work will be needed at this landfill to evaluate the level of hazard posed by it.

- Site 14 -- Transformer Oil Drainage Area

A series of twelve surface soil samples were collected inside a bermed area previously used to drain transformers. The samples were collected from 0 to 0.5 feet in a matrix that covered the entire area. Two of the samples were collected from an area with no vegetation. These were the only ones that contained significant levels of either oil and grease (O&G) or PCB. One of the two samples contained about 4% oil and grease compounds and 5.3 μg/g of the PCB Aroclor 1260. The other sample contained elevated concentrations of O&G but no PCBs (see Figure IV-32). Based on the analytical results and the pattern of barren soil in the part of the site nearest to the road, it appears that most transformer draining occurred in one area of the site. Previous sampling reported in the Phase I report found 14 mg/kg (μg/g) PCBs at one location (unspecified). Both the 14 μg/g and the 5.3 μg/g findings are well below the current TTLC value of 50 μg/g.

No samples were taken below 6 inches, so the depth of the contamination is unknown. Typically PCB compounds, and to a lesser degree O&G compounds, do not mobilize significantly through soil. The berm around the site eliminated the possibility of lateral spreading outside the site. In addition, analysis of the soil samples indicates minimal spreading within the site. This site does not



See Table IV-13 for specific results.

All other samples are below detection limits for O & G and PCBS.

Map Scale 1" ≈ 120'

Figure IV-32
Significant Analytical Results
Site 14 Transformer Drainage
Beale Air Force Base

AeroVironment Inc.

pose a significant environmental threat. The health threat is also considered to be low because of the low concentration of PCB and because the site is located in a relatively remote part of the base. However, there is no fencing and Beale's mobile home camping facility is located within 700 feet.

- Site 15 -- Landfill No. 3

Four wells were installed to monitor the active base landfill, one up gradient and three down gradient. None of the groundwater samples collected during the two sample rounds showed evidence of groundwater contamination. This was expected because the management practices employed at the landfill include no chemical waste disposal, runon and runoff control, and covering the waste daily. The site is operated in accordance with state regulations for a nonhazardous sanitary landfill. This active landfill poses no significant environmental threat.

- Site 16 -- Explosives Ordnance Disposal Site

Two soil samples were collected from the bottom of the trench used for disposal of scrap metal at the Explosives Ordnance Disposal Area. Waste material remaining after bullets, flares and small shells are detonated is placed in the unlined trench, which is about 70 feet long by 15 feet wide by 10 feet deep. The first round of samples was collected in November 1985 when no water was in the trench. Three samples were collected from the top 2 to 3 inches of soil at various locations along the bottom of the trench. Very high lead, chromium and barium concentrations were found. Based on the results of the first sampling, a second round of samples was collected in April. At that time, the trench was partially filled with water from the spring rain. The second sample submitted to the laboratory was a composite of soil collected from six locations along both sides of the trench, just below the waterline. Results from the second sample showed lower concentrations of metals, but they were still at levels significantly above background. The difference in concentrations found at the bottom rather than along the sides of the trench is not surprising, as most waste lies at the bottom and little along the sides where the second samples were collected.

The lead concentration found in the first sample (14,000 μg/g) is 14 times higher than the TTLC criteria set up by the California Department of Health Services. The chromium concentration of 2000 μg/g in the soil was very close to the 2500 μg/g threshold limit for total chromium. No sampling was done to determine the vertical extent of contamination in soil or groundwater, but an E.P. Toxicity test run on the second sample showed that lead and chromium were reduced by an order of magnitude in the leachate. Additional sampling in the trench will be required to determine whether the very high concentrations of lead and chromium at the surface have migrated to deeper soil, especially because of the presence of ponded water in the pit during several months of the year.

o Site 17 -- Best Slough

There appears to be no environmental degradation at the Best Slough site. This site was added to the statement of work to evaluate whether contamination had occurred as a result of the disposal of several drums in a depression near where Best Slough passes the three bridges area. None of the soil samples collected at the site showed any contamination. Additionally, the surface water sample collected from the Slough near the depression was clean.

These results were expected, because there were no odors, soil staining or evidence of chemicals in or near the drums. In fact, the drums appear to have been dumped in the depression after they were burned in some way. They were found to be badly rusted, but there is no evidence of chemical residue on the inner or outer surfaces. This site poses no environmental threat.

o Site 18 -- Bulk Fuel Storage Facility

Four soil borings were drilled at the bulk fuels storage facility. None of the samples showed significant contamination by oil and grease compounds, lead or volatile/purgable organics. Some of the samples contained up to 400 μg/g of O&G or petroleum hydrocarbons, but similar concentrations were also found in the background samples. Even samples taken from the boring located at the reported gasoline spill showed no significant contamination, which indicates

that either no spill occurred or that the spill was very limited in scope. The analytical results agree with our field observations, which included no organic vapors, visible staining or other evidence of poor fuel management. This site is thought to pose no threat to the nearby environment.

V. ALTERNATIVE MEASURES

Eighteen sites at Beale AFB were investigated for the presence of chemical contamination during the Phase II, Stage 1 study. The results of this study showed that seven of the sites were free of any detectable contamination. Some contamination has been identified at the other eleven sites and follow-on action may be required, including additional investigation, continued monitoring, remedial action or operational changes.

This chapter discusses the actions that could be taken at each of the eighteen sites, based on the knowledge gained from this program and previous studies. The discussion will concentrate on feasible alternatives, presenting only practical and cost-effective options. At least two options are available at each site. Generally, these are for continued monitoring or additional investigation. In some instances, limited cleanup measures are presented for sites with localized contamination. This work would be completed under a Phase IV IRP effort. Also included are options for changes to waste management and practices. These would limit additional damage to the environment until final decisions about the site are made.

AeroVironment makes specific recommendations in the following chapter, but the Air Force and regulating agencies will need to judge the overall merits of each option to determine whether it meets safety, economic and environmental policy goals. The sites are discussed in the order of their priority before the Phase II, Stage 1 study.

A. Site 1 -- West Drainage

Contaminants at the West Drainage apparently result from fuel and other hydrocarbons being washed off the flightline area by surface runoff and discharged from the drainage system into the unlined stream channel. Surface water and sediment samples were collected about 750 feet from the drainage outlet. Sediments were found to contain 33,000 μg/g of oil and grease and surface water upstream from the oil booms contained an observable layer of jet fuel during the

April 1986 sampling round. Surface water does not flow offbase except during a major storm, typically occurring over several days.

Groundwater samples collected from the monitoring well at this site show trichloroethylene (TCE) contamination exceeding California DOHS action levels. The current groundwater flow is south from this site, so base production wells to the west are not immediately downgradient from Site 1. However, base production wells are susceptible to contamination because their gravel pack extends up into the water table aquifer.

Actions that could be taken at the West Drainage are outlined below. Because problems are known to exist in surface water/soil and groundwater, a combination of options will probably be required.

1) Continued monitoring of the existing well: This would help define the level of TCE contamination and, in concert with other well measurements, check the direction of flow in the area.

2) Installation of additional groundwater-monitoring wells: These wells would monitor groundwater conditions (contamination and flow) between the site and on-base or off-base groundwater wells. Wells would be drilled to the water table aquifer and the underlying confined aquifer.

3) Collection of additional sediment and surface water samples: These samples would determine the downstream extent of water/soil contamination. Sampling could be planned to assure that a surface water sample is collected from the base border during flow conditions.

4) Cleanup: If sufficient information exists, cleanup of surface soils or groundwater could be initiated under Phase IV.

5) Implementation of a management program to eliminate further hydrocarbon runoff: Runoff control or collection and treatment would keep the fuel and other contaminants from entering the stream channel.

B. Site 2 -- Photo Wastewater Treatment Plant and Injection Well No. 2

Site 2 must be treated as two separate sites, because the waste pond and injection wells are in different locations and pose different problems. The unlined waste ponds have been used in the past to dispose of sludge generated by the Photo Wastewater Treatment Plant. Four groundwater monitoring wells were installed in May 1985 to monitor contamination resulting from the ponds. Two sets of samples collected from these wells showed concentrations of phenol and chromium. These results are similar to previously reported sample results from May - July 1985.

The injection well system was investigated for evidence of contamination resulting from periodic flushing of pipes and well filters. One well and four soil borings were drilled to identify contamination in the shallow soil and water table aquifer. Results indicate deep soils and groundwater may be contaminated by phenolic compounds.

Actions that could be taken at the Injection Well for Stage 2 include:

1) No action: since the potential contamination identified at the site is localized and of limited concentration and thus presents no serious threat to the environment, no action need be taken.

2) Drilling deeper soil borings in the vicinity of the injection wells: These borings would determine whether the contamination at the bottom of one Stage 1 boring is an indication of deep soil contamination.

3) Installation of a groundwater-monitoring well at the second injection well head: Another monitoring well would check the groundwater conditions near the other potential sources at this site.

Possible actions at the waste pond include:

1) Continued monitoring using the existing well system: Periodic sampling at the four Radian wells located around the pond system would check the concentrations of phenols and metals.

2) Closure: under Phase IV, a closure plan acceptable to regulatory agencies could be prepared and further environmental contamination from the ponds would be eliminated.

C. <u>Site 3 -- Fire Protection Training Areas</u>

Sampling of groundwater-monitoring wells at the Fire Protection Training Areas (FPTA) indicates that the water table aquifer has not been contaminated by the fire training activities. No significant concentrations were reported in any of the five wells from either sampling round. Although FPTAs are typically problems on Air Force bases, the lack of a widespread problem probably results from the infrequent usage of the FPTA and the high clay content of underlying soils. Lack of groundwater contamination indicates that no widespread contamination exists.

Soil samples were collected at the FPTA to determine whether shallow soil contamination exists at specific locations. The results show that the burn pit at FPTA No. 2 and the underground fuel tank area have oil and grease and fuel components in the shallow soil. The problem at the burn pit is typical of FPTA operations because that is where the fuel is spread prior to burning. The hydrocarbons at the underground tank probably result from surface spilling, not a tank leak. Other areas, including the suspected FTPA No. 1 were found to be uncontaminated.

Actions that could be taken at the FPTA for Stage 2 include:

1) No action: If the problems at the FPTA are sufficiently localized that deep soils and groundwater are not threatened, this alternative would be appropriate, since limited human activity occurs at this site.

2) Additional drilling at the burn pit and underground tank: This would define the vertical extent of hydrocarbon contamination and its lateral spread.

3) Continued sampling of the existing groundwater monitoring wells: This would monitor groundwater for change over time.

4) Removal of the underground tank: Under Phase IV, the underground tank could be replaced by an aboveground, double-contained tank. This would comply with current California regulations on underground storage tank management and minimize the risk of tank leakage or further surface spills.

D. Site 4 -- Battery Shop Dry Well

The Battery Shop was investigated by drilling a groundwater-monitoring well into the water table aquifer. The monitoring well was placed about 20 feet from the old 20-foot-deep dry well that had been used for disposal of neutralized battery acid.

During drilling, staining was observed in soil samples from 45 feet to 55 feet. No visual evidence of metals deposition was encountered in the zone from 20 feet to 45 feet. This seems to indicate that no contamination of shallow soil has occurred at the Battery Shop. No groundwater contamination was identified in either round of samples from the 140-foot monitoring well.

Actions that could be taken at Battery Shop Dry Well include:

1) No action: If the site has caused no current damage or poses no future risk to the environment, no action need be taken.

2) Continued sampling of the monitoring well at this site: This would monitor groundwater for change over time.

3) Drilling a deep boring and sampling the stained soil at the 45- to 55-foot zone: This would determine whether the staining seen during well drilling is the result of metals deposition.

4) Placing a cement cap over the top of the dry well: Sealing the top of the dry well would assure that no additional dumping occurs in the well and that water does not drain into it and mobilize any contaminants.

E. Site 5 -- SR-71 Shelter

Sampling at the SR-71 Shelter detected oil and grease in the upper soils near the drainage system inlet. Samples from some of the borings have detectable concentrations of oil and grease and fuel components that are the result of fuel spills, primarily on the SR-71 Shelter apron. While borings at the south (uphill) end of the site were uncontaminated, northern surface soils are stained at the surface and are contaminated to 16 feet. No sampling was conducted below 16 feet or away from the centerline of the drainage swale.

One groundwater monitoring well was installed and sampled. It was found to be free of contamination. This indicates that there is no widespread problem at this site and that detectable fuel contamination is limited to the upper soils. Fuel runoff occurs regularly at this site.

The SR-71 Shelter is very closely linked to the problems at the West Drainage (Site No. 1). Surface runoff which enters the drainage inlet at this site exits the drainage system at the West Drainage. Other parts of the base also drain into the West Drainage, but the SR-71 Shelter is probably one of the major contributors of hydrocarbons into the West Drainage system.

Actions that could be taken at the SR-71 shelter include:

1) No action: If soil contamination at the site is localized and deep soils and groundwater are not threatened currently or in the future, no action need be taken, especially since no human activity occurs at this site.

2) Continued sampling at the monitoring well at this site: This would monitor groundwater to determine whether any change occurs over time.

3) Additional drilling and soil sampling along the drainage swale: Soil samples could be collected to greater depths up and down the channel, and away from the channel centerline to determine the extent of soil contamination. Sampling could also include surface soils in the restricted area at the edge of the SR-71 Shelter apron.

4) Implementation of a runoff management program: The goal of this activity would be to minimize or eliminate the runoff of fuel and other hydrocarbons into the drainage system. This would also help to reduce the problem at Site 1, the West Drainage.

F. Site 6 -- Landfill No. 2

Samples collected from two groundwater-monitoring wells located downgradient from Landfill No. 2 indicate that no organic or inorganic contamination of groundwater has resulted from this site. Both rounds of samples from each well were uncontaminated. The landfill was in operation from 1950 to 1980, so it is unlikely that chemical wastes (other than a limited amount of photo wastewater sludge) would have been deposited at this site.

Actions that could be taken at this landfill include:

1) No action: If the site presents no threat of environmental degradation, no action need be taken.

2) Continued sampling of existing monitoring wells: The two monitoring wells installed in Stage 2 could be sampled periodically to determine whether changes in groundwater flow patterns occur.

G. Site 7 -- Biological Production Site

Sixteen surface soil samples were collected at the Biological Production Site to evaluate the possibility of contamination resulting from biological research previously conducted by the Army at this location. The results show that no contamination exists at this site. This finding agrees with Army reports, which indicate that no contamination was left after the Army departed from the site.

Actions that could be taken at the Biological Production Site include:

1) No action: No contaminants remain at the site and no threat to the environment exists, so no action need be taken.

2) Additional shallow soil sampling: If further questions exist about the site conditions, samples could be collected at more locations around the site and at depths greater than 0 - 0.5 feet.

H. Site 8 -- J-57 Test Cell

The J-57 Test Cell is used to test the engines from all aircraft used at Beale, except the SR-71. During the process of testing, some fuels and other hydrocarbons are spilled and washed off of the concrete test stand and into a small drainage ditch that encircles the site. Soil samples from the drainage channel indicate that soil contamination exists in the upper soils at one location. The soil at that location was stained. Samples from other locations further down the drainage ditch were not contaminated. Groundwater samples collected from the monitoring well at this site were also uncontaminated. These results indicate that the hydrocarbon contamination in the soil is limited both vertically and laterally to the point where runoff enters the ditch.

Actions that could be taken at the J-57 Test Cell include:

1) No action -- If the problem at this site is sufficiently localized that deep soils and groundwater are not threatened, no action need be taken.

2) Continued sampling of the monitoring well at this site -- Groundwater sampling would determine whether any change occurs in the groundwater conditions.

3) Additional soil sampling along the drainage ditch: Soil samples would provide more information on the vertical and lateral extent of hydrocarbon contamination along the drainage channel.

4) Implementation of a runoff management program: As for other sites, the goal of this effort would be to minimize or eliminate the runoff of hydrocarbons into the unlined drainage channels.

I. Site 9 -- Entomology Shop, Building 2560

Three soil borings were drilled and sampled at Building 2560. One was drilled inside the gravel pad area used for mixing and rinsing the pesticides used at the base. Chlordane was found in the soil, down to a depth of 6.5 feet. A second boring, drilled downgradient and in the area with no vegetation, showed no pesticides and herbicides.

Actions that could be taken at Site 9 include:

1) No action: If chlordane contamination at this site is localized and does not present a threat to deeper soils and groundwater, no action need be taken, especially since only Entomology Shop workers have access to this site.

2) Additional drilling and soil sampling: Drilling would define the extent of contamination within the gravel mixing area.

3) Removal of contaminated soil and redesign of the mixing basin: A limited amount of soil could be removed and the gravel basin could be replaced with a lined collection system.

J. Site 10 -- J-58 Test Cell

Laboratory analyses of soil samples taken at the J-58 Test Cell show the effects of past fuel spills and poor housekeeping near an aboveground fuel storage tank. Samples taken in the drainage channel near the tank and at other locations along the channel detected levels of oil and grease down to 1.5 feet. Deeper samples were not taken during this effort, so the vertical boundary of the contaminated soil is not known. Discoloration and odor were observed in the drainage channel near the tank and test stand. Groundwater from the monitoring well down gradient from the site is uncontaminated. These results indicate that although surface contamination exists, the problem has probably not spread to deeper zones.

Actions that could be taken at the Site 10 Test Cell include:

1) No action: If problems at the J-58 Test Cell are localized and no widespread environmental damage is suspected, no action need be taken, especially since limited human activity occurs at the site.

2) Additional soil sampling in area of known contamination: Deeper soil sampling using a hollow-stem auger drill rig would define the extent of contamination in three dimensions.

3) Additional soil sampling along the drainage ditch: Soil samples would provide more information on the vertical and lateral extent of hydrocarbon contamination along the drainage channel.

4) Remedial Actions: Possible remedial actions would include soil removal and secondary containment for the offending tank, or simply instituting an environmental management plan that addresses fuel spills.

K. Site 11 -- AGE Maintenance

A gravel pad behind the AGE Maintenance Shops receives wash-down water and fuel spill runoff. This area has elevated levels of oil and grease in the upper five feet. Water that does not infiltrate into the soil in the pad runs off into a drainage ditch. Samples from four two-foot borings in the ditch did not show elevated levels of oil and grease, which indicates that the contamination at the site is limited to the pad area.

One well was installed to monitor groundwater downgradient from the gravel pad and drainage ditch. Samples from this well showed no detectable groundwater contamination.

Actions that could be taken include:

1) No action: If soil contamination found at this site is sufficiently localized that no widespread environmental damage will occur, no action need be taken.

2) Additional soil sampling along the drainage ditch: Soil samples would provide more information on the vertical and lateral extent of hydrocarbon contamination along the drainage channel.

3) Installing another downgradient monitoring well: The existing monitoring well is generally downgradient from the drainage ditch but is not ideally situated to monitor the area of contaminated soil. A second groundwater-monitoring well may be desirable in the parking area of the AGE building to detect contamination from the gravel pad.

4) Remedial Action: If the area of contaminated soil has been adequately defined, it could be excavated or the area paved. Another activity would be to install a runoff collection system.

L. Site 12 -- Entomology Shop, Building 440

Three soil borings were completed near Entomology Building 440, one up gradient from the site to establish background levels and two at the concrete pad suspected of being the mixing location. Samples indicate no significant pesticide contamination of the soil in these areas.

Actions that could be taken at Site 12 include:

1) No action: This option would be appropriate because the site does not appear to pose a threat to the environment.

2) Additional soil sampling: Sampling would determine whether other parts of the site are contaminated from entomology activities.

M. Site 13 -- Landfill No. 1

Two groundwater-monitoring wells were installed down gradient from Landfill No. 1. Although the landfill was never reported to receive chemical wastes, the groundwater was found to contain TCE. Levels of TCE in the two wells varied widely on the first round (106 vs. 0.4 ppb) but were very similar on the second round (28 vs. 26 ppb). A number of buried objects were identified during the geophysical survey of the landfill, but geophysical surveys at landfills are inconclusive. It is not known whether Landfill No. 1 is the source of the TCE.

Bottom sediment and surface water samples were taken at four sites along the creek that runs along the southwest boundary of the site. The bottom sediment was uncontaminated, but pesticide was found in all the surface water samples. The pesticide is probably not from the landfill, since the concentration in the sample was the same as the concentration in samples taken next to the landfill.

Actions that could be taken at Site 13 include:

1) Continue monitoring the existing wells: Sampling would verify the levels of TCE in the groundwater and detect any changes.

2) Install an upgradient monitoring well: One or more wells located up gradient from Landfill No. 1 would determine whether the TCE contamination found in Wells 13-01 and 13-02 is being generated by the landfill. The upgradient wells at the nearby Photo Wastewater Treatment Plant could also be sampled.

3) Additional surface water samples: Stream samples would better quantify the levels of pesticide found in Hutchinson Creek and determine the source.

N. Site 14 -- Transformer Drainage Area

Twelve surface soil samples were taken in a grid pattern to investigate possible PCB contamination at the Transformer Drainage Area. Oil and grease contamination, as well as the PCB Aroclor 1260, were found in one sample taken in a bare area of the site. Elevated levels of these contaminants were not found in other samples from the site, which indicates that the contamination is localized.

Actions that could be taken at Site 14 include:

1) No action: If no threat of environmental degradation of deep soils or groundwater exists because contamination is localized, no action need be taken, especially as no human activity occurs at this site.

2) Additional soil sampling in the area of known contamination: This would define the extent of contamination in three dimensions; the initial survey did not extend deeper than 0.5 feet.

3) Remedial Actions: Work would include removing soil that has been identified as contaminated, covering the site, or removing the berm around it to let rainwater run off the site instead of percolating through the contaminated soil.

O. Site 15 -- Landfill No. 3

Landfill No. 3 is the active base landfill. Four wells were installed to monitor groundwater in the uppermost water-bearing zone: one up gradient (east of the perimeter road) and three down gradient (west of the fill area). The water quality in the downgradient wells was no different from that in the upgradient well. The landfill does not appear to be degrading the groundwater beneath the site.

Because this is an active landfill, the actions that can be taken are limited by state regulations. They include:

1) Continued monitoring of the existing wells: To comply with state regulations, the Air Force will have to continue monitoring the four wells at this site. The specific time schedule and analyses will be determined by the California Regional Water Quality Control Board.

2) Drilling an additional upgradient well: Although this action will probably not be required under the state permit, one more upgradient well would better characterize the quality of water entering the site.

P. Site 16 -- Explosives Ordnance Disposal (EOD)

The EOD is used to dispose of active explosives and munitions. After burning in a secure area, the remaining scrap metal is disposed of in a shallow trench on site. Surface soil samples were taken in the bottom and along the sides of the trench. Lead was found in the soil at levels above the California criteria for classification as a hazardous waste. In addition, chromium was found at levels near the hazardous waste criteria.

Actions that could be taken at EOD include:

1) Additional soil sampling: Additional soil borings would define the vertical extent of the contaminated soil.

2) Installation of a groundwater monitoring well: This option would be appropriate because the high lead content of the soils may pose a threat to the groundwater beneath the site.

3 Remedial Actions: Actions could include excavating bottom soils from the metal disposal pit or developing a more efficient scrap metal collection and decontamination method.

Q. Site 17 -- Best Slough

At Best Slough, three small trenches containing rusted 55-gallon drums were investigated using a hollow-stem auger and shallow hand-auger borings. No contamination was found in any of the samples. A surface water sample collected in the adjacent stream showed no contamination. There appears to be no environmental hazard at this site.

Actions that could be taken at Site 17 include:

1) No action: This option would be appropriate because this site does not appear to pose a threat to the environment.

2) Additional soil sampling: The sampling would identify whether contamination exists at other locations on the site.

R. Site 18 -- Bulk Fuel Storage Facility

The Bulk Fuel Storage Facility is the main fuel storage facility at Beale AFB. Potential soil contamination at this site was investigated with four 20-foot soil borings sited in drainage ditches around the storage tanks and near a reported spill at the tank car unloading area. Samples from the four borings indicate that the site is uncontaminated.

Actions that could be taken at Site 18 include:

1) No action: This option would be appropriate because no known environmental damage has occurred at the Bulk Fuel Storage Facility.

2) Additional soil sampling: The Storage Facility is a large area with many tanks. Soil samples could be collected at other areas of the site, including the bermed area that provides secondary containment of the jet fuel tanks.

3) Installation of groundwater-monitoring well(s): This would check for groundwater contamination from this site. No groundwater monitoring wells exist downgradient from the site at this time. If a slow leak occurred from one of the jet fuel or gasoline tank bottoms, a monitoring well would help detect the problem.

VI. RECOMMENDATIONS

This chapter outlines AeroVironment's recommendations for further work related to the IRP program at Beale AFB. Sites are categorically designated as follows:

Category I: Sites where no further action (including remedial action) is required.

Category II: Sites requiring additional monitoring or work to quantify or further assess the extent of current or future contamination.

Category III: Sites that will require remedial action (ready for IRP Phase IV action).

Eighteen potential hazardous waste sites were investigated during the Phase II Stage 1 study. Groundwater contamination was identified at only three sites: the West Drainage, Landfill No. 1 and Injection Well No. 2. Since the landfill and injection well sites are located next to each other, their problems may be interrelated. Surface water and sediment contamination was also identified at the West Drainage. The most prevalent problem at Beale AFB is the shallow soil contamination caused by spills or leaks of fuels, lubricants or other hydrocarbons. This problem was identified at five sites: the FPTA, the SR-71 shelter, AGE Maintenance, and both of the engine test cells. Additional shallow soil contamination was identified at the current Entomology Shop and the old Transformer Drainage Area. These two problems are very localized.

AeroVironment believes that twelve of the sites should be classified as Category I, requiring no additional IRP action. Six sites will require additional Phase II study before final decisions can be made about the degree of hazard posed to the environment. None of the sites are ready to be moved to Phase IV for cleanup or other remedial action. Some sites recommended for additional Phase II study will need some work in both Phase II and Phase IV, but have been listed as

Phase II until additional sampling is completed to allow remedial action. Table VI-1 summarizes the recommendations for all sites; specific recommendations are made below.

AV's recommendation for additional wells and soil borings of specific depths and at specific locations are based on current knowledge. This knowledge does not include information about the conditions of the soil vertically and laterally from the Stage 1 sampling locations. Thus contract limits for Stage 2 on drilling footage and sample collection must be adjustable so that these can be modified in the field to address the exact site conditions and to define the extent of contamination. All additional wells should be designed using the California Department of Health Services "Site Mitigation Decision Tree."

Site 1 -- West Drainage (Category II)

Surface water, stream-bottom sediments and groundwater were all found to be contaminated by organic chemicals that had run off from the storm drainage system into the unlined west ditch. Surface water leaving the base was not sampled because the channel had no substantial flow. Sediments were sampled only within 750 feet of the beginning of the ditch because the ditch channel is less clearly defined beyond that point, but sediment contamination was detected 750 feet downstream. Groundwater contained TCE in concentrations above state DOHS action levels, but no TCE was detected in the upgradient wells at the AGE Maintenance Shop, the Battery Shop Dry Well or the SR-71 Shelter. Groundwater flow in the area is not directly toward the base production wells, but eventual contaminant migration to the production well area may be possible.

Additional sampling should be conducted downstream from the head of the ditch. It should include quarterly monitoring of the surface water, with at least two samples collected at the base boundary when the flow is sufficient to define the channel. After flow patterns have been determined, sediments should be collected from the surface and from two feet at eight downstream locations. Water samples should be tested for VOCs (EPA 601/602), lead (EPA 239.2), oil and grease (EPA 413.2). Sediments should be tested for VOCs (EPA 8010/8020 + 5030), lead (EPA 239.2 + 3050), and oil & grease (EPA 413.2 + 3550).

TABLE VI-1. Recommendations.

Site	Recommendation
1 West Drainage (Category II)	- Install three groundwater monitoring wells, two between Site 1 and the base production wells and a third at the base boundary, downgradient from the site. - Sample the 4 wells (1 existing and 3 proposed) and test for VOCs (EPA 601/602) and oil & grease (EPA 413.2) - Sample surface water and stream bottom sediments at 8 downstream locations. . Analyze surface water for VOCs (EPA 601/602), lead (EPA 239.2), and oil & grease (EPA 413.2). . Analyze bottom sediment for VOCs (EPA 8010/8020 + 5030), lead (EPA 239.2 + 3050), and oil & grease (EPA 3550/413.2) - Identify sources of organic material which flow into west ditch and implement a plan to eliminate the flow of contaminants to this site.
2 Injection Well No. 2 (Category II)	- Drill 3 soil borings to 30 feet near the inactive injection wells. Analyze for Phenols (EPA 8040 +3550), 8 Metals (Series 200 + EPA 3050) and oil & grease (EPA 413.2 + 3550). - Continue monitoring the 5 wells on site (1 at injection wells and 4 at sludge disposal area) and analyze for Phenols (EPA 604), Benzene (EPA 602) and 8 Metals (Series 200).
3 Fire Protection Training Area (Category II)	- Continue monitoring the 5 existing wells. Sample groundwater for VOCs (Method 601/602). - Drill up to 8 additional soil borings near the underground tanks and burn pit. Analyze soil samples for oil and grease (EPA 3550 extraction, EPA 413.2 analysis) and VOCs (EPA 8010/8020 + 5030). - Remove the underground storage tanks as a Phase IV activity.

TABLE VI-1. (con't)

4	Battery Shop Dry Well (Category I)	-	No further action is recommended.
5	SR-71 Shelters (Category II)	-	Drill up to 8 additional 20-foot soil borings between the taxiway and SR-71 apron, analyze for volatile aromatics (EPA 8020 +5030) and oil & grease (EPA 413.2 +3550).
		-	Continue monitoring groundwater in the existing well, analyze for volatile aromatics (EPA 602) and oil & grease (EPA 413.2).
		-	Collect up to 10 hand auger samples from 5 locations along the edge of the SR-71 shelter apron. Analyze for same parameters as soil boring samples.
6	Landfill No. 2 (Category I)	-	No further action is recommended.
7	Biological Production Site (Category I)	-	No further action is recommended.
8	J-57 Test Cell (Category I)	-	No further IRP action is recommended. However, a fuel spill management plan should be implemented to minimize further fuel releases.
9	Entomology Shop, Bldg. 2560 (Category I)	-	No further IRP action is recommended. However, the existing gravel basin should be replaced with an impermeable basin and a liquid collection system.
10	J-58 Test Cell (Category I)	-	No further IRP action is recommended. However, a fuel spill management plan should be implemented to minimize further fuel releases.
11	AGE Maintenance (Category I)	-	No further IRP action is recommended. However, a fuel spill management plan should be implemented to minimize further fuel releases.
12	Entomology Shop, Bldg. 440 (Category I)	-	No further action is recommended.

TABLE VI-1. (Con't)

13	Landfill No. 1 (Category II)	-	Continue monitoring existing wells semiannually, sample for TCE (Method 601) and Phenol (Method 604)
		-	If warranted after continued sampling of existing wells, install 2 additional wells upgradient and downgradient of Landfill 1 near property line.
14	Transformer Drainage (Category I)	-	No further IRP action is recommended. However, the berm should be removed and the soil used to cover the surface of the site.
15	Landfill No. 3 (Category I)	-	No additional IRP work is needed. However, the base should continue necessary groundwater monitoring for landfill permit.
16	EOD (Category II)	-	Install 1 groundwater monitoring well. Sample groundwater and analyze for metals (Series 200).
		-	Install 3 temporary piezometers to determine groundwater gradient before selecting the well location.
		-	Phase IV remedial action Determine depth and excavate soil from beneath waste metal trench.
17	Best Slough (Category I)	-	No further action is recommended.
18	Bulk Fuel Storage Facility (Category I)	-	No further IRP action is recommended. However, the base should consider the installation of two monitoring wells to monitor for leaks which may occur from the fuel storage area.

Three additional groundwater monitoring wells should be completed down gradient from Well 01-01. Two would be placed roughly between Well 01-01 and the base production wells near the base boundary. They should be drilled to the water table aquifer. The third well should be installed at the base boundary downgradient from the site, also in the water table aquifer. AV estimates that all the wells should be drilled to a depth of 120-feet. These three new wells, along with Well 01-01, should be sampled twice a year and analyzed for VOCs (EPA 601/602) and for O&G.

Finally, a comprehensive study should be conducted to identify the sources of the organic material (primarily jet fuel) that continues to flow into the West Drainage ditch. A plan should be prepared and implemented to minimize or eliminate the flow of additional contaminants to this site. No cleanup can be undertaken until the source of the problem is managed.

Site 2 -- Injection Well No. 2 (Category II)

Groundwater contamination was identified in the monitoring wells surrounding the photowaste sludge disposal area. The type and level of contamination are similar to that reported after sampling conducted in 1985 by Radian Corporation for USAF OEHL. Some phenol was detected in the well AeroVironment installed there, but the significance of the findings is questionable because of the laboratory method used for phenol analysis.

Pentachlorophenol (PCP) was identified in the deepest soil sample analyzed from this site; thus the soils near the wellhead or blowdown valve at the end of the pipe may be contaminated to a deeper level, especially since PCP is relatively mobile in soil. PCP was added to the treatment plant effluent that flows through this system until February 1986.

AV recommends that deeper soil samples be collected near the active injection wells. These samples will determine the extent of PCP contamination in the soil. Three borings should be drilled to depths of 30 feet and up to three samples collected from each boring. Soil samples should be analyzed for phenols (EPA 8040 + 3550), 8 metals (series 7000 + 3050), and oil and grease (EPA 413.2 + 3550). The five wells at Site 2 should continue to be sampled twice a year and

analyzed for benzene (EPA 602), phenols (EPA 604), and 8 metals (series 200). Phenol should be analyzed by the more sensitive methods 8040/604, so that the levels can be gauged more accurately.

Site 3 -- Fire Protection Training Area (Category II)

Five groundwater monitoring wells were installed and sampled at the FPTA and no contamination was evident. However, soil samples collected near the underground storage tank and inside the burn pit at FPTA No. 2 show localized fuel contamination. The hydrocarbons at the storage tank are probably from surface spills, not a tank leak, but no secondary containment exists and the tank system will soon need modifications to satisfy state regulations. The burn pit is not lined and all three borings drilled there showed surface contamination, but all showed a general decrease in concentration with depth.

The five groundwater monitoring wells should continue to be sampled twice yearly and the water tested for volatile organics by EPA Methods 601/602. Additional soil testing should be conducted in the area of the underground tank to determine the lateral and vertical extent of contamination. Up to eight 20-foot hollow-stem-auger borings should be drilled (and drilling monitored with an organic vapor analyzer) and samples should be collected at surface, 5-, 10-, 15- and 20-foot depths. Soil samples should be tested for oil and grease (EPA 413.2 + 3550) and VOCs (EPA 8010/8020 + 5030).

Either in conjunction with this soil-testing program, or as a separate Phase IV activity, the underground tank should be removed and replaced with an aboveground tank possessing secondary containment. Base officials report that this activity is currently being planned. Tank removal should be accomplished in compliance with all applicable California and Yuba County tank regulations.

Site 4 -- Battery Shop Dry Well (Category I)

AV recommends that no further action be taken at the Battery Shop Dry Well because no contamination was found in this study and no environmental hazard is believed to exist.

Site 5 -- SR-71 Shelter (Category II)

No groundwater problem was identified at the SR-71 Shelter, but significant soil contamination has resulted from jet fuel runoff from the SR-71 Shelter apron or the flightline taxiway. The three northernmost soil borings showed highly elevated hydrocarbons in the upper 11 feet of soil. The analytical results appear to match the level of surface staining, which is greatest near the drainage system inlet.

Additional soil samples should be collected to better define the extent of the soil contamination at the northern end of the site. Eight 20-foot hollow stem auger borings should be drilled to determine the lateral and vertical extent of hydrocarbon contamination (including the extent of contamination away from the swale centerline). Five samples should be collected from each boring. Organic vapor readings should be taken in conjunction with this sampling. Additionally, ten soil samples should be collected from five hand-auger holes at the edge of the SR-71 Shelter apron to determine the extent of soil contamination at the edge of the gravel (the first point of possible infiltration). All soil samples should be analyzed for volatile aromatics (EPA 8020 + 5030) and oil and grease (EPA 413.2 + 3550). The groundwater monitoring well should also be sampled twice yearly, and the water analyzed for volatile aromatics (EPA 602) and oil and grease (EPA 413.2).

Because the runoff from the SR-71 Shelter is probably a major source of the surface water contamination at the West Drainage (Site 1), this site should be a major area of investigation in the study recommended above for Site 1. Special attention should be paid to managing fuel runoff from the SR-71 aircraft while they sit at the shelter apron.

Site 6 -- Landfill No. 2 (Category I)

AV recommends that no further action be taken all Landfill No. 2 because no significant contamination was found in this study and no environmental hazard is believed to exist.

Site 7 -- Biological Production Site (Category I)

AV recommends that no further action be taken at the Biological Production Site because no significant contamination was found in this study and no environmental hazard is believed to exist.

Site 8 -- J-57 Test Cell (Category I)

Soil samples collected from the drainage ditch around the J-57 Test Stand show only very localized, shallow hydrocarbon contamination at the point where runoff from the stand enters the ditch. No solvents were identified in any of the soil samples. No groundwater contamination is evident, based on the results of AV's sampling.

AV recommends no further IRP action be taken at the J-57 Test Cell because the contamination identified is 1) very localized and shallow, 2) not likely to move either down the drainage channel or toward groundwater and 3) not a health risk to workers. The only human activity at this site is jet engine testing. Workers are routinely exposed to much higher concentrations of hydrocarbons during test work than the concentrations found in the drainage ditch. However, AV recommends that a fuel spill management plan be implemented to minimize further releases of hydrocarbons into the drainage ditch.

Site 9 -- Entomology Shop, Building 2560 (Category I)

Soil samples collected inside (and under) the gravel mixing basin at Building 2560 showed detectable concentrations of the pesticide Chlordane. This is the result of mixing chemicals and rinsing containers in this basin. However, no

pesticides or herbicides were detected outside the basin, even in the area immediately downgradient. In addition, the concentration of chlordane found in the soil is less than half the state's total threshold limit concentration (TTLC).

AV recommends no further IRP action be taken at the Entomology Shop because the contamination identified is 1) very localized, 2) below state TTLC and 3) not a health risk to workers. The site is located behind a locked fence and only accessible to workers. These workers routinely handle concentrated pesticides. However, AV does recommend that the Entomology Shop replace the gravel basin with an impermeable basin and liquid collection system to minimize further releases at this site.

Site 10 -- J-58 Test Cell (Catagory I)

Soil samples collected from the surface of the drainage ditch around the J-58 Test Stand show localized, shallow hydrocarbon contamination. Samples collected from 1.5 feet generally showed no contamination. No solvents were identified in any of the soil samples. No groundwater contamination is evident, based on the results of AV's sampling.

AV recommends no further IRP action be taken at the J-58 Test Cell because the contamination identified is 1) very localized and shallow, 2) not likely to move either down the drainage channel or toward groundwater and 3) not a health risk to workers. The only human activity at this site is jet engine testing. Workers are routinely exposed to much higher concentrations of hydrocarbons during test work than the concentrations found in the drainage ditch. However, AV recommends that a fuel spill management plan be implemented to minimize further releases of hydrocarbons into the drainage ditch.

Site 11 -- AGE Maintenance (Category I)

Soil samples collected from the edge of the east-side parking area at the AGE Maintenance Shop show localized, shallow hydrocarbon contamination resulting from runoff of fuels and other petroleum, oil and lubricant spills.

However, no elevated oil and grease levels extend below six feet in depth and no evidence of hydrocarbons was found in the drainage channel located twenty feet from the parking area. Also, no groundwater contamination is evident, based on results of AV's sampling.

AV recommends no further IRP action be taken at the AGE Maintenance Shop because the contamination identified is 1) very localized and shallow, 2) not likely to move either down the drainage channel or toward groundwater and 3) not a health risk to workers. The only human activity at this site is equipment maintenance. Workers are routinely exposed to much higher concentrations of hydrocarbons during work activities than the concentrations found in the soil. However, AV recommends that a spill management plan be implemented to minimize further releases of hydrocarbons into the soil.

Site 12 -- Entomology Shop, Building 440 (Category I)

AV recommends that no further action be taken at Building 440 because no significant contamination was found in this study and no environmental hazard is believed to exist.

Site 13 -- Landfill No. 1 (Category II)

Groundwater contamination was identified in the two wells sampled at Landfill No. 1. Trichloroethene (TCE) was found at levels exceeding DOHS action levels; however, the repeatability of these data was not good. Trace levels of lindane, aldrin and 2,4-D were found in Hutchinson Creek in April, but are the result of upstream source(s).

The two groundwater-monitoring wells should be sampled at least twice more to define the concentration of TCE in the wells better. Samples should be taken six months apart and the water analyzed for volatile chlorinated organics by EPA Method 601 and for phenols by EPA 604 (because of the proximity to the injection well system). After the TCE concentrations are better defined, additional groundwater-monitoring wells may be warranted. Depending on the severity of the

problem, one or two wells may be needed, one upgradient and one downgradient near the base property line. Both would be drilled into the water table aquifer (approximately 100 feet).

Surface water samples should be collected at various locations along Hutchinson Creek to determine the extent and source of the pesticides and 2,4-D found in the water. The samples should be analyzed for pesticides and herbicides (SM509A, 509B).

Site 14 -- Transformer Drainage Area (Category I)

Soil sampling indicates that a small portion of the Transformer Drainage Area contains high concentrations of oil and grease and detectable concentrations of the PCB Aroclor 1260. Based on the results of AV's sampling, the problem is limited to the bare ground nearest the southeast corner of the site. No samples were taken below 0-0.5 feet, but because of the immobile nature of oils and PCBs in soil and the low concentration of the PCB (5.3 µg/g detected versus 50 µg/g TTLC standard), we do not believe there is any migration of these compounds.

AV recommends no further IRP action be taken at the Transformer Drainage Area because the contamination identified is 1) very localized 2) an order of magnitude below the TTLC and 3) in an area where there is little chance for human contact. However, as a precaution, AV recommends that the berm around the site be removed. The dirt from the berm should be spread over the site to eliminate the possibility of casual contact by base residents.

Site 15 -- Landfill No. 3 (Category I)

AV does not recommend further IRP action at Landfill No. 3 as a result of the findings of this study. However, the base will need to implement a regularly scheduled sampling program of the four groundwater monitoring wells at this site. No environmental hazard is expected from this site as long as proper landfill management is continued.

Site 16 -- EOD (Category II)

Soil samples collected from the scrap metal trench at EOD show that a large portion of the top six inches of soil contained lead and chromium. Lead concentrations are high enough to classify the soil as hazardous waste, and the chromium concentration is near the criteria level. The water from rain and runoff standing in the trench six months out of the year aggravates the situation by providing a hydraulic driving force to potentially move the metals (leaching).

A groundwater monitoring well is needed to determine whether groundwater in the area has been degraded. The well should be drilled to first water (water table aquifer) and sampled twice per year for metals. Three temporary PVC piezometers should be installed to determine the site-specific groundwater gradient before the location of the monitoring well is selected. The piezometers should be removed and abandoned according to state and county specifications at the end of the project. Also, a Phase IV remedial action should be undertaken to excavate the metal waste and upper soils (at least down to native soil) from the trench and to grade the site to eliminate further ponding of water. Additional soil sampling will be needed to better define the extent of waste material and to verify that all contaminated soil has been removed, but this should be done as part of the Phase IV removal.

Site 17 -- Best Slough (Category I)

As a result of the findings of this study, AV recommends that no further IRP action be taken for this site. No environmental hazard is believed to exist.

Site 18 -- Bulk Fuels Storage Facility (Category I)

As a result of the findings of this study, AV recommends that no further IRP action be taken for this site. No environmental hazard is believed to exist at present. However, AV recommends that the base consider the installation of two (or more) groundwater monitoring wells immediately downgradient of the fuel storage facility to help monitor for future releases from the bottoms of the aboveground storage tanks.

APPENDIX A

Definitions, Nomenclatures and Units of Measurement

A. DEFINITIONS, NOMENCLATURES AND UNITS OF MEASUREMENT

ACUREX: Laboratory selected to analyze samples collected during field investigation at Mather Air Force Base.

AF: Air Force.

AFB: Air Force Base.

Ag: Chemical symbol for silver.

AGE: Aircraft ground equipment.

AIR-ROTARY DRILLING: A method for boring holes in the earth employing air rather than water to remove cuttings from the hole.

AL: DOHS action level.

ALLUVIUM: Materials eroded, transported and deposited by streams.

ANOMALY: A local feature distinguishable in a geophysical measurement.

AQUICLUDE: Poorly permeable formation that impedes groundwater movement and does not yield to a well or spring.

AQUIFER: A geologic formation, group of formations, or part of a formation that is capable of yielding water to a well or spring.

AQUITARD: A geologic unit which impedes groundwater flow.

AROMATIC: Description of organic chemical compounds in which the carbon atoms are arranged in a ring associated with special electron stability. Aromatic compounds are often more reactive than nonaromatics.

ARTESIAN: Groundwater contained under hydrostatic pressure.

As: Chemical symbol for arsenic.

AV: AeroVironment Inc.

AVGAS: Aviation Gasoline.

Ba: Chemical symbol for barium.

BAILER: A tubular piece of equipment with a check valve at one end consisting of a simple ball and seat arrangement. It is lowered down a well via a rope and pulley system to collect well water samples.

BEE: Bioenvironmental Engineer

BENTONITE: A clay formed from the decomposition of volcanic ash which has great ability to absorb or adsorb water and to swell accordingly. It is commonly used to seal a groundwater well in a nonscreened area.

BES: Bioenvironmental Engineering Services.

BIODEGRADABLE: The characteristic of a substance to be broken down from complex to simple compounds by microorganisms.

BLS: Below land surface.

BLIND DUPLICATE: A field replicate sample submitted to a laboratory as a routine sample for analysis without any identification as a quality control sample. The purpose of blind duplicate samples is to monitor sampling and analytical precision without the introduction of laboratory bias.

BNA: Base/neutral, acid fraction of priority pollutants.

BRAIDED STREAM: A stream flowing in several dividing and reuniting sections, the cause of the division being the obstruction by sediment deposited by the stream.

CAPILLARY FRINGE: The zone overlying the saturated zone containing capillary interstices which may be filled with water.

CENOZOIC: The latest of the four eras into which geological time is divided.

Cd: Chemical symbol for cadmium.

CHAIN-OF-CUSTODY: The documentation of sample possession, beginning at collection and ending at analysis. A chain-of-custody form accompanies samples and records the data and time of each sample possession transfer.

CHRISTIE BOX: A small reinforced concrete box with locking steel cap which is cemented to the ground. It is used to complete a well at the surface so that the top is flush to the ground.

CLASTIC: Consisting of fragments of rocks or of organic structures that have been moved individually from their places of origin.

CLAY: A sediment particle having a diameter less than 1/512 mm.

CONDUCTIVITY: A property of an electric conductor defined as the electrical current per unit area divided by the voltage drop per unit length.

CONFINED AQUIFER: An aquifer bounded above and below by impermeable strata or by geologic units distinctly less permeable than the aquifer itself.

CONFINING UNIT: An aquitard or other poorly permeable layer which restricts the movement of groundwater.

CONSOLIDATION: The adjustment of a saturated soil in response to increased load. Involves the squeezing of water from the pores and decrease in void ratio.

CONTAMINATION: The degradation of natural water quality or soil to the extent that its usefulness is impaired. This term does not imply any specific limits, since the degree of contamination which is permissible depends on the end use for which the water is intended.

CONE OF DEPRESSION: The depression produced in a water table or piezometric surface by pumping or artesian flow.

Cr: Chemical symbol for chromium.

CRETACEOUS: The later of the three periods comprising the Mesozoic era.

DBCP: Dibromochloropropane.

DH: Drill hole.

DISPOSAL FACILITY: A facility or part of a facility at which hazardous waste is intentionally placed into or on land or water, and at which waste will remain after closure.

DISPOSAL OF HAZARDOUS WASTE: The discharge, deposit, injection, dumping, spilling, or placing of any hazardous waste into or on land or water so that such waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwater.

DoD: Department of Defense.

DOHS: California Department of Health Services.

DOWNGRADIENT: In the direction of decreasing hydraulic static head; the direction in which groundwater flows.

DRILLING: Air rotary drilling.

DRINKING QUALITY WATER: Water meeting primary drinking water standards.

DRIVE CASING: A casing which is driven into a bore hole to prevent caving.

DUMP: An uncovered land disposal site where solid and/or liquid wastes are deposited with little or no regard for pollution control or aesthetics. Dumps are susceptible to open burning and are exposed to the elements, disease vectors and scavengers.

EASTING: One of the two values indicating the position of a point in the California State Plane Coordinate System, Zone 2 (see Northing).

EDB: Ethylenedibromide

EFFECTIVE PRECIPITATION: The mean annual precipitation minus the mean annual evaporation.

EM: Electromagnetic survey.

EOCENE: Strata of the Tertiary era, between the Paleocene and Oligocene.

EPA: U.S. Environmental Protection Agency.

E.P. TOXICITY: Extraction procedure toxicity, one criteria for determining whether a material is a hazardous waste. The E.P. toxicity test is a leachate simulation established by EPA to determine whether toxic material will leach from the waste over time. The test method is specified in 40 CFR 261, Appendix II.

EPHEMERAL STREAM: A stream or portion of a stream which flows only as a direct response to precipitation.

EROSION: The wearing away of land surface by wind, water, or chemical processes.

EXPLOSIMETER: Monitoring device for detecting explosive gases in ambient air by reading percent of lower explosive limit.

FIELD BLANK: A blank sample that is kept in the sample storage area throughout the sampling activities. After activities are over, this sample is analyzed to see whether the storage environment has introduced contaminants to the samples.

FLOOD PLAIN: The lowland and relatively flat areas adjoining inland and coastal areas of the mainland and off-shore islands, including, at a minimum, areas subject to a one percent or greater chance of flooding in any given year.

FLOW PATH: The direction or movement of groundwater as governed principally by the hydraulic gradient.

FLUVIAL: Of, or pertaining to rivers; produced by river action.

FPTA: Fire Protection Training Area.

GC/MS: Gas chromatograph/mass spectrometer, a laboratory instrument for separating and identifying unknown organic compounds.

GEOPHYSICAL SURVEY: The exploration of an area in which geophysical properties and relationships unique to the area are mapped by one or more methods.

GPR: Ground Penetrating Radar.

GRAVEL: A collective term for sediments whose particle sizes are greater than 2 mm.

GRAVEL PACK: A gravel of particular size used to encase the area of the well through which the groundwater enters. In this way, it acts as a conduit for the groundwater.

GROUND PENETRATING RADAR: A method used in a geophysical survey which uses radar transmissions to detect a boundary between media with different electrical and physical properties in order to locate buried objects and estimate the thickness of landfill covering layers.

GROUNDWATER: Water beneath the land surface in the saturated zone that is under atmospheric or artesian pressure.

GROUNDWATER RESERVOIR: The earth materials and the intervening open spaces that contain groundwater.

HARDPAN: A hard impervious layer composed chiefly of clay and cemented by relatively insoluble materials which limits the downward movement of water.

HARM: Hazard Assessment Rating Methodology.

HAZARDOUS SUBSTANCE: Under CERCLA, the definition of hazardous substance includes:

1. All substances regulated under Paragraphs 311 and 307 of the Clean Water Act (except oil)

2. All substances regulated under Paragraph 3001 of the Solid Waste Disposal Act

3. All substances regulated under Paragraph 112 of the Clean Air Act

4. All substances which the Administrator of EPA has acted against under Paragraph 7 of the Toxic Substance Control Act

5. Additional substances designated under Paragraph 102 of the Superfund bill

HAZARDOUS WASTE: As defined in RCRA, a solid waste, or combination of solid wastes, which because of its quantity, concentration, or physical, chemical or infectious characteristics may cause or significantly contribute to an increase in mortality or an increase in serious, irreversible, or incapacitating reversible illness; or pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed.

HAZARDOUS WASTE GENERATION: The act or process of producing a hazardous waste.

HEAVY METALS: Metallic elements, including the transition series, which include many elements required for plant and animal nutrition in trace concentrations but become toxic at higher concentrations.

Hg: Chemical symbol for mercury.

HOLDING TIME: The amount of time after sampling in which a sample must be analyzed or extracted, according to the EPA.

HOLLOW STEM AUGER: A method by which drilling is accomplished by rotating the hollow stem augers into the soils. An auger's design is similar to a large screw with protruding flights replacing the screw's threads. As augers are "screwed" into the soils, the cuttings are brought to the surface on the rotating flights.

HYDROCARBONS: Organic chemical compounds composed of hydrogen and carbon atoms chemically bonded. Hydrocarbons may be straight chain, cyclic, branched chain, aromatic, or polycyclic, depending upon arrangement of carbon atoms. Halogenated hydrocarbons are hydrocarbons in which one or more hydrogen atoms has been replaced by a halogen atom.

I.D.: Inside diameter.

IGNEOUS: Formed by solidification from a molten or partially molten state.

INDURATED: Sediments hardened by heat, pressure or natural concentration.

INFILTRATION: The movement of water through the soil surface into the ground.

IRP: Installation Restoration Program.

JP-4: Jet Propulsion Fuel Number Four, military jet fuel.

JP-7: Jet Propulsion Fuel Number Seven, military jet fuel.

LEACHATE: A solution resulting from the separation or dissolving of soluble or particulate constituents from solid waste or other man-placed medium by percolation of water.

LEACHING: The process by which soluble materials in the soil, such as nutrients, pesticide chemicals or contaminants, are washed into a lower layer of soil or are dissolved and carried away by water.

LINER: A continuous layer of natural or man-made materials beneath or on the sides of a surface impoundment, landfill, or landfill cell which restricts the downward or lateral escape of hazardous waste, hazardous waste constituents or leachate.

LITHOLOGY: The description of the physical character of a rock.

LOAM: A soil composed of a mixture of clay, silt, sand and organic matter.

LOQ: Level of quantification generally considered by laboratories to be five to ten times the method detection limit. This is the lowest concentration which can be reported precisely.

MB: Main Base water production well.

MAGNETOMETER SURVEY: A measurement of magnetic intensity in an area of earth.

MDL: Method detection limit, which is the lowest concentration of a compound which can be detected with the given laboratory method.

MEHRTEN FORMATION: A stratigraphic section comprised of volcanic-derived angular gravels and sand, dark matic rock fragments, mudflows. It is discontinuous, with abundant cross-bedding and cut-and-fill structures.

MEK: Methyl Ethyl Ketone.

MESOZOIC: One of the eras of geologic time, following the Paleozoic and succeeded by the Cenozoic era.

METALS: See "Heavy Metals."

METAMORPHIC: Segregation of certain minerals into lenses and bands accomplished by altering rock composition, texture and internal structure through pressure, heat and the introduction of new chemical substances.

MOGAS: Motor gasoline.

MONITORING WELL: A well used to measure groundwater levels and to obtain samples.

MSL: Mean sea level.

MUD ROTARY DRILLING: A drilling method for boring holes in the earth that employs water to remove cuttings from the hole.

NONINTRUSIVE: Method of investigation in which information may be gained without disturbing the object being investigated.

NORTHING: One of two values indicating the position of a point in the California State Plane Coordinate System, Zone 2 (see Easting).

OD: Outside diameter.

O_2: Oxygen molecule.

OEHL: Occupational and Environmental Health Laboratory.

O&G: Symbols for oil and grease analysis.

ORGANIC: Being, containing or relating to carbon compounds, especially in which hydrogen is attached to carbon.

OVA: Organic vapor analysis.

OXYGEN DEFICIENCY: This occurs when air contains less than 16% oxygen, insufficient to support human life.

PALEOZOIC: The group of rocks deposited during the era between the Late Precambrian and Mesozoic eras.

Pb: Chemical symbol for lead.

PCB: Polychlorinated Biphenyl; liquids used as a dielectrics in electrical equipment.

PCE: Tetrachloroethene (Perchloroethylene).

PELLICULAR: A term applied to liquid adhering as films to the surfaces of openings in the zone of aeration.

PERCHED WATER TABLE: A water table above a relatively impermeable zone underlain by unsaturated rocks of sufficient permeability to allow ground-water movement.

PERCOLATION: Movement of moisture by gravity or hydrostatic pressure through interstices of unsaturated rock or soil.

PERMEABILITY: The capacity of a porous rock, soil or sediment for transmitting a fluid without damage to the structure of the medium.

PERSISTENCE: As applied to chemicals, those which are very stable and remain in the environment in their original form for an extended period of time.

PESTICIDE: An agent used to destroy pests. Pesticides include such specialty groups as herbicides, fungicides, insecticides, etc.

PET HC: Petroleum hydrocarbon.

pH: The negative logarithm of the hydrogen ion activity that indicates the acidity or basicity of a sample.

PHENOL: Total recoverable phenolics -- any of various acidic compounds analogous to phenol and regarded as hydroxyl derivatives of aromatic hydrocarbons.

PLEISTOCENE: The earlier of the two epochs comprising the Quaternary period of geology.

PLUME: The spreading of a contaminant in a fanning-out manner from the source.

POL: Petroleum, oil and lubricants.

POLLUTANT: Any introduced gas, liquid or solid that makes a resource unfit for a specific purpose.

POTENTIOMETRIC SURFACE: The imaginery surface to which water in an artesian aquifer would rise in tightly screened wells penetrating it.

PPB: Parts per billion by weight, equivalent to µg/kg, or µg/l for water.

PPM: Parts per million by weight, equivalent to µg/g, or mg/l for water.

psi: Pounds per square inch.

PRECIPITATION: Rainfall.

Pt: Geological abbreviation for the pretertiary basement complex.

Ptm: Geological abbreviation for the Laguna-Mehrten transition zone.

Pv: Geological abbreviation for the Mehrten Formation.

QA/QC: Quality assurance/quality control.

Qr: Geological abbreviation for quaternary river deposits.

Qtl: Geological abbreviation for the laguna formation.

Qv: Geological abbreviation for the victor formation.

RADIAN WELLS: Groundwater monitoring wells installed by Radian Corporation in May 1985 to monitor photowaste sludge ponds at Beale AFB. The wells were numbered PWP-01 through PWP-04.

RCRA: Resource Conservation and Recovery Act.

RECEPTORS: The potential impact group or resource for a waste contamination source.

RECHARGE: The addition of water to the groundwater system by natural or artificial processes.

RECHARGE AREA: A surface area in which surface water or precipitation percolates through the unsaturated zone and eventually reaches the zone of saturation. Recharge areas may be natural or man-made.

RECORDS SEARCH: The IRP Records Search for Beale Air Force Base, compiled and written by Engineering-Science.

RESISTIVITY: A factor of the limit to a steady electric current in a conductor that depends upon the material and its physical condition.

RFB: Request for bids.

RING SAMPLE: A soil sample taken with a two-inch diameter tubular ring.

RPD: Relative percent difference.

SAC: Strategic air command.

SAND: Particles of sediment having diameters larger than 1/16 mm (62 microns) and smaller than 2 mm.

SANITARY LANDFILL: A land disposal site using an engineered method of disposing solid wastes on land in a way that minimizes environmental hazards.

SATURATED ZONE: That part of the earth's crust in which all voids are filled with water.

SCS: U.S. Department of Agriculture Soil Conservation Service.

Se: Chemical symbol for selenium.

SILT: Sediment particles having diameters larger than 1/512 mm (2 microns) and smaller than 1/16 mm (62 microns).

SLUDGE: The solid residue resulting from a manufacturing or wastewater treatment process that also produces a liquid stream.

SOLID WASTE: Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment, or air pollution control facility and other discarded material, including solid, liquid semisolid, or contained gaseous material resulting from industrial, commercial, mining, or agricultural operations and from community activities. This does not include solid or dissolved materials in domestic sewage, solid or dissolved materials in irrigation return flows, industrial discharges which are point sources subject to permits under Section 402 of the Federal Water Pollution Control Act, as amended (86 USC 880), or source, special nuclear, or by-product material as defined by the Atomic Energy Act of 1954 (68 USC 923).

SOW: Statement of work.

SPECIFIC RETENTION: The ratio of (1) the volume of a liquid which, after being saturated, will retain against the pull of gravity to (2) its own volume. It is stated as a percentage.

SPIKE: A quality control check consisting of a chemical or solution of a known concentration presented to the lab for analysis as an unknown, or the addition of a known quantity of analyte to a sample by the analyst to assess method accuracy.

SPILL: Any unplanned release or discharge of a hazardous substance onto or into the air, land, or water.

SPLIT SAMPLE: A second sample taken from the same site as the original sample to assess sampling and/or laboratory precision; a duplicate sample.

STORAGE OF HAZARDOUS WASTE: Containment, either on a temporary basis or for a longer period, in such a manner as not to constitute disposal of such hazardous waste.

Surrogate: Same as a spike (defined above).

SWL: Static water level.

TCE: Trichloroethylene.

TOXICITY: The ability of a material to produce injury or disease upon exposure, ingestion, inhalation, or assimilation by a living organism.

TREATMENT OF HAZARDOUS WASTE: Any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to render it nonhazardous.

UNSATURATED ZONE: Zone above the water table. Most of the time, the pore space between soil particles in this zone is filled with air, except near grain-to-grain boundaries where surface tension maintains a film of water between the particles.

UPGRADIENT: In the direction of increasing hydraulic static head; the direction opposite to the prevailing flow of groundwater.

USAF: United States Air Force.

USGS: United States Geological Survey.

VICTOR FORMATION: A stratigraphic section comprised of heterogeneous fluvial clay-to-gravel sediments. It also contains lenticular deposits from banded streams and is mostly made up of silty sand.

VOA: Volatile organic analysis, purgeable fraction of priority pollutants.

VOC: Volatile organic compounds.

VOLATILE COMPOUNDS: Those materials whose vapor pressures are sufficiently high such that they may become concentrated in any gaseous phase that forms; readily vaporizable.

WATER TABLE: Surface of a body of unconfined groundwater at which the pressure is equal to that of the atmosphere.

WELL DEVELOPMENT: The process by which a well is swabbed and pumped until the water produced is free of sediment.

WELL SCREEN: The portion of the well casing which is situated in the water-bearing strata and contains .02-inch slits to allow groundwater to enter the well.

WDC: Water Development Corporation.

APPENDIX B

References

REFERENCES

California Administrative Code, Title 22, Hazardous Waste Management Regulations, Division 4, Chapter 30.

California Department of Water Resources (1978): Evaluation of Groundwater Resources: Sacramento Valley, California. Bulletin 118-6, August.

California Department of Water Resources (1980): Groundwater Basins in California, Report to the Legislature in Response to Water Code Section 12924, Bulletin 148-80, January.

California Division of Mines and Geology (1969): Jenkins, O.P., Geomorphic Map of California.

California Regional Water Quality Control Board (1985): Marshack, Jon B., Waste Classification and Cleanup Level Determination, Guidance Document, 21 November.

Engineering Science (1984): Phase I: Records Search Beale AFB, California, April.

Federal Register (1984): Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act. Vol. 49, No. 209, October 26.

Herbert, F.W., and Begg, E.L. (1969): Soils of the Yuba Area California, University of California, Davis, Department of Soils and Plant Nutrition, in Cooperation with County of Yuba, California.

Jenkins, O.P. (1965): Geologic Map of California, Chico Sheet; California Division of Mines and Geology; Scale 1:250,000.

Olmsted, F.J. and Davis, G.H. (1961): Geologic Features and Groundwater Storage Capacity of the Sacramento Valley, California; U.S. Geological Survey Water-Suply Paper 1497.

Page, R.W. (1974): Base and Thickness of the Post-Eocene Continental Deposits in the Sacramento Valley, California; U.S. Geological Survey Water-Resources Investigations.

Personal Communication (1985): Mr. D.B. Engel, Yuba County Agricultural Commision, September.

Personal Communication (1985): Mr. Tom Thomas, USAF Occupational and Environmental Health Laboratory, February.

Radian Corporation (1985): Monitoring of Photo Waste Sludge Ponds, Beale Air Force Base, California, October.

Standard Methods for the Examination of Water and Wastewater (1985): 16th Edition.

USDA (1985): Soil Survey of Beale Air Force Base. Soil Conservation Service, January.

U.S. Environmental Protection Agency (1975): Use of water balance method for predicting leachate generation from solid waste disposal sites. EPA/530/SW-168

U.S. Environmental Protection Agency (1976): Quality Criteria for Water. U.S. Government Printing Office.

U.S. Environmental Protection Agency (1979): Chemical Methods for the Analysis of Water and Wastes. EPA 600/4-79-020.

U.S. Environmental Protection Agency (1982): Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater. EPA 600/4-82-057.

U.S. Environmental Protection Agency (1979): Handbook for Analytical Quality Control in Water and Wastewater Laboratories. EPA 600/4-79-019.

U.S. Environmental Protection Agency (1982): Test Methods for Evaluating Solid Waste: Physical/Chemical Methods. SW846, 2nd Ed.

USGS (1977): USGS Open File Report 77-748. Marchand, E.E., and A. Alwardt. Late Cenozoic Stratigraphic Units, Northeastern San Joaquin Valley, California, 136.

USGS (1978): USGS Open File Report 78-10. Rockwell, Gerald. Description of Wells at Beale Air Force Base, January.

USGS (1980): USGS Open File Report 80-204. Page, R.W., Ground-Water Conditions at Beale Air Force Base and Vicinity, California, April.

Roy F. Weston, Inc. (1984): Phase II, Stage I Problem Confirmation Pre-Survey Report, Beale Air Force Base, November.

DATE
FILMED
0-8